

Finnigan™ SpectraSYSTEM™

Isocratic Pumps
Reference Manual

A0099-585 Revision E

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Name _____

Title _____

Company _____

Address _____

City/State/Postal Code _____

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Telephone _____ Ext. _____

Isocratic Pump Serial # _____ Date Purchased _____

Tell us more... Let us know more about how you use this product:

My Organization Is: (Check one only)

- ☐ Commercial (for profit) lab
- ☐ Government lab
- ☐ Hospital / Clinic
- ☐ Research Institute
- ☐ University / College
- ☐ Veterinary
- ☐ Other _____

Job Function: (Check one only)

- ☐ Administration
- ☐ Lab Management
- ☐ Operator
- ☐ Other _____

My Primary Application Is: (Check one only)

- ☐ Analytical
- ☐ Biomedical
- ☐ Clinical / Toxicology
- ☐ Energy
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- ☐ Forensic / Toxicology
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*Finnigan SpectraSYSTEM and SpectraSERIES
Isocratic Pumps Reference Manual*

*Revision E
A0099-585*

	Strongly Agree	Agree	Disagree	Strongly Disagree
The manual is well organized.	1	2	3	4
The manual is clearly written.	1	2	3	4
The manual contains all of the information I need.	1	2	3	4
The instructions are easy to follow.	1	2	3	4
The instructions are complete.	1	2	3	4
The technical information is easy to understand.	1	2	3	4
The figures are helpful.	1	2	3	4
I was able to operate the system by using this manual. (If not, please comment below.)	1	2	3	4

Additional Comments: (Attach additional sheets if necessary.)

Tear this sheet from the manual, fold it closed, stamp it, and drop it in the mail.

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Contents

Back Pocket

Quick Reference Cards
Menu Trees

Contents	i
Technical and Customer Support	iii
Safety and EMC Information.....	vii
Manual Conventions	xix
Chapter 1 Installation and Specifications	1
Introduction.....	1
Start-up Checklist.....	2
Unpacking	3
Installation	5
Performance Verification.....	18
Specifications	21
Chapter 2 A Quick Example	23
Introduction.....	23
Learning Your Way Around	23
Instrument Control	25
Practice Examples	29
Chapter 3 Basic Operations	33
Introduction.....	33
Theory of Operation.....	33
SpectraSYSTEM and SpectraSERIES Isocratic Pumps	33
Instrument Startup.....	36
Some Routine Operations	37
The File(s) Menu	37
Purging Solvent Lines	46
Starting a Run	49
The Commands Menu (P1500 only)	51
Status.....	53
Monitoring Pump Performance.....	56
Shutting Down at the End of the Day.....	57
Chapter 4 Advanced Operations	59
Introduction.....	59
The Options Menu	59
The Queue Menu (P1500 only).....	63
The Tests Menu	70

Chapter 5 Required Maintenance	89
Introduction	89
Maintenance Schedule	90
Maintenance Log	90
Extending the Maintenance Period	94
Maintenance Procedures	95
Maintenance Tips	114
Repair Instructions	116
Appendix A Troubleshooting	119
Introduction	119
Theory of Operation	119
Troubleshooting Your Pump	120
Appendix B Glossary	129
Appendix C Kits and Parts Lists	135
Introduction	135
Accessory Kit	135
Standard Maintenance Kit	136
Inert/Biocompatible Maintenance Kit	136
Standard LC Fittings Kit	137
Inert/Biocompatible LC Fittings Kit	137
Piston Flush Seal Kit (10 mL)	138
Piston Seal Kit (30 mL)	138
Solvent Inlet Tube Kit	138
Solvent Tube Extension Kit	138
Manual Injection Valve Bracket Kit	139
Narrow-bore Upgrade Kit	142

Index

List of Tables

Table 1.1 Eight-pin port pin assignments	9
Table 1.2 Pump connections to a SpectraSYSTEM or SpectraSERIES autosampler	17
Table 3.1 File Characteristics for Isocratic Pumps	34
Table 3.2 Purging mechanisms for the three purge modes	47
Table 3.3 Status Messages	53
Table 4.1 Check Valve Test Results	74
Table 4.2 Flow Calibration Modes	76
Table 4.3 Errors indicating possible System PCBA failure	85
Table 5.1 Gradient Pump Preventative Maintenance Schedule	90
Table A.1 General Troubleshooting Table	121
Table A.2 Pump-specific Hardware Problems	123
Table A.3 Error Messages	126
Table A.4 Display Messages	127
Table A.5 Solvent Compatibility for Pump Wetted Surfaces	128

Technical and Customer Support

This manual contains procedures for installing your equipment and verifying that it is operating within specifications. It will also help you understand how to use and care for your equipment. For additional support, contact one of the customer service offices listed below.

In North America

In North America, Thermo Electron San Jose Customer Service Engineers are available from the following offices:

Northeastern Region

Phone [1] (732) 627-0220

Fax [1] (732) 627-0260

Southern Region

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Fax [1] (770) 516-6916

Central Region

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Fax [1] (847) 310-0145

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Fax [1] (408) 965-6123

Canada

Phone [1] (905) 712-2258

Fax [1] (905) 712-4203

REPLACEABLE PARTS

Contact Customer Service Operations to order replaceable parts. The location and telephone and fax numbers for North America are as follows:

North America Customer Service Operations

1400 Northpoint Parkway, Suite 10

West Palm Beach, FL 33407

Phone: [1] (800) 532-4752

Fax: [1] (561) 688-8731

TECHNICAL SUPPORT

You can contact Technical Support at the following location, telephone and fax numbers, and e-mail address:

North America Technical Support Operations

1400 Northpoint Parkway, Suite 10
West Palm Beach, FL 33407

Phone: [1] (800) 685-9535

Fax: [1] (561) 688-8736

E-mail: techsupport.finnigan@thermo.com

In Europe

In Europe, customer support, replaceable parts, and technical support are available from each of the following offices.

Technical support is also available from North America Technical Support Operations at the following phone number and e-mail address:

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E-mail techsupport.finnigan@thermo.com

Wien (Vienna), Austria

Phone [43] (01) 333 50 34-0

Fax [43] (01) 333 50 34-26

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Fax [81] (45) 453-9110

Osaka, Japan

Phone [81] (06) 6387-6681

Fax [81] (06) 6387-6641

Beijing, P.R. China

Phone [86] (010) 6621 0839

Fax [86] (010) 6621 0851

For all other countries, contact your local Thermo Electron San Jose products dealer.

Safety and EMC Information

In accordance with our commitment to customer service and safety, these instruments have satisfied the requirements for the FCC and the European CE Mark including the Low Voltage Directive.

Designed, manufactured and tested in an ISO9001 Registered facility, this instrument has been shipped to you from our manufacturing facility in a safe condition.



CAUTION! This instrument must be used as described in this manual. Any use of this instrument in a manner other than described here may result in instrument damage and/or operator injury.

IDENTIFYING SAFETY INFORMATION

This reference manual contains precautionary statements that can prevent personal injury, instrument damage, and loss of data if properly followed. All statements of this nature are called to your attention through the use of bold type and the following icons:



CAUTION!



HOT
SURFACE!



HIGH
VOLTAGE!

Every instrument has specific hazards, so be sure to read and comply with the following precautions. They will help ensure the safe, long-term use of your system.

1. Before plugging in any of the instrument modules or turning on the power, always make sure that the voltage and fuses are set appropriately for your local line voltage.
2. Only use fuses of the type and current rating specified. Do not use repaired fuses and do not short-circuit the fuse holder.
3. The supplied power cord must be inserted into a power outlet with a protective earth contact (ground). When using an extension cord, make sure that the cord also has an earth contact.
4. Do not change the external or internal grounding connections. Tampering with or disconnecting these connections could endanger you and/or damage the system.



CAUTION! The instrument is properly grounded in accordance with regulations when shipped. You do not need to make any changes to the electrical connections or to the instrument's chassis to ensure safe operation.

5. Never run the system without the housing on. Permanent damage can occur.
6. Do not turn the instrument on if you suspect that it has incurred any kind of electrical damage. Instead, disconnect the power cord and contact a Service Representative for a product evaluation. Do not attempt to use the instrument until it has been evaluated. (Electrical damage may have occurred if the system shows visible signs of damage, or has been transported under severe stress.)
7. Damage can also result if the instrument is stored for prolonged periods under unfavorable conditions (*e.g.*, subjected to heat, water, etc.).
8. Always disconnect the power cord before attempting any type of maintenance.
9. Capacitors inside the instrument may still be charged even if the instrument is turned off.
10. Never try to repair or replace any component of the system that is not described in this manual without the assistance of your service representative.

GOOD LABORATORY PRACTICES

Keep Good Records

To help identify and isolate problems with either your equipment or your methodology, we recommend that you keep good records of all system conditions (*e.g.*, % RSDs on retention times and peak areas, peak shape and resolution). At a minimum, keep a chromatogram of a typical sample and standard mixture, well-documented with system conditions, for future reference. Careful comparison of retention times, peak shapes, peak sensitivity, and baseline noise can provide valuable clues to identifying and solving future problems.

Chemical Toxicity

Although the large volume of toxic and flammable solvents used and stored in laboratories can be quite dangerous, don't ignore the potential hazards posed by your samples. Take special care to read and follow all precautions that ensure proper ventilation, storage, handling, and disposal of both solvents and samples. Become familiar with the toxicity data and potential hazards associated with all chemicals by referring to the manufacturers' Material Safety Data Sheets (MSDS).

Sample Preparation

Always consider the solubility of your sample in the solvent/mobile phase. Sample precipitation can plug the column, tubing and/or flow cell causing flow restriction. This obstruction may result in irreparable damage to the system. Particulate matter can be avoided by filtering the samples through 0.45 or 0.2 micron (or less) filters.

Solvent Requirements

Many chemical manufacturers provide a line of high-purity or spectro-quality reagents that are free of chemical impurities. Routine filtration of all solvents or eluents through a 0.45 or 0.2 micron (or less) fluorocarbon filter before placing them in the solvent reservoir will significantly prolong the life and effectiveness of the inlet filters, check valves and seals, injector, and column. Typically, HPLC-grade solvents do not require filtration.

Choose a mobile phase that's compatible with the sample and column you've selected for your separation. Remember that some solvents are corrosive to stainless steel. Inert, biocompatible versions of instruments are also available from Thermo Electron.

Degas the Eluents

Degas your eluent solvents using either the vacuum degassing or the helium sparging technique. A complete description of these techniques is found in separate documentation provided with degassing accessories.

Solvent Disposal

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

emical.

High-pressure Systems and Leaks

LC systems operate at high pressures. Because liquids aren't highly compressible they do not store much energy. Accordingly, there is little immediate danger from the high pressures in an LC system. However, if a leak occurs, it should be corrected as soon as possible. Finally, we recommend that you always wear eye and skin protection when working on an LC system and that you always shut down the system and return it to atmospheric pressure before attempting any maintenance.

Information sur la sécurité et la compatibilité électromagnétique (CEM)

Selon notre engagement à assurer à nos clients service et sécurité, ces instruments sont déclarés conformes aux normes de la FCC et à la réglementation européenne (CE), y compris à la directive sur les basses tensions.

Conçu, fabriqué et testé dans une installation homologuée ISO9001, cet instrument a été livré à partir de notre usine de fabrication dans le respect des règles de sécurité.



MISE EN GARDE ! Cet instrument doit être utilisé selon les instructions figurant dans ce manuel. Le non respect des consignes d'utilisation de cet instrument décrites dans le présent manuel risque d'endommager l'instrument et/ou d'infliger des blessures à l'opérateur.

IDENTIFICATION DES INFORMATIONS SUR LA SÉCURITÉ

Ce manuel de référence contient des précautions d'usage afin de prévenir tout dommage corporel ou matériel ainsi que toute perte de données lorsque l'opérateur se conforme aux instructions indiquées. Ces instructions sont accompagnées des icônes suivantes et sont affichées en caractères gras pour attirer l'attention de l'opérateur :



MISE EN
GARDE !



SURFACE
BRÛLANTE !



HAUTE
TENSION !

Chaque instrument présentant des dangers spécifiques, il incombe à l'opérateur de lire les précautions suivantes et de s'y conformer, afin de maintenir la durée de vie et la sécurité du système.

1. Avant de brancher un module d'instruments ou de le mettre sous tension, toujours s'assurer que la tension et les fusibles sont réglés de façon à correspondre à la tension locale du secteur.
2. N'utiliser que des fusibles du type et du courant nominal spécifiés. Ne pas utiliser de fusibles réparés et ne pas court-circuiter le porte-fusible.

3. Le cordon d'alimentation accompagnant l'instrument doit être branché à une prise de courant avec mise à la terre. En cas d'utilisation d'une rallonge électrique, s'assurer que celle-ci comporte également une mise à la terre.
4. Ne pas modifier les connexions de mise à la terre internes ou externes. La modification ou le débranchement de ces connexions représente un danger pour l'opérateur et/ou risque d'endommager le système.



MISE EN GARDE ! Cet instrument est mis à la terre conformément aux règlements applicables lors de son expédition. Ne pas modifier les branchements électriques ou le châssis de l'instrument afin d'assurer un fonctionnement en toute sécurité.

5. Ne jamais faire fonctionner le système sans son boîtier. Des dommages permanents pourraient en résulter.
6. Ne pas mettre l'instrument sous tension si celui-ci a subi des dommages électriques. Débrancher le cordon d'alimentation de l'appareil et consulter un représentant du service technique pour procéder à un examen du produit. Ne pas essayer d'utiliser l'instrument avant qu'il n'ait été examiné. (Des dommages électriques peuvent s'être produits si le système montre des signes visibles d'endommagement ou si les conditions de transport ont été extrêmement difficiles.)
7. L'instrument peut également être endommagé s'il est entreposé pendant une période de temps prolongée, dans de mauvaises conditions (par exemple, s'il est exposé à la chaleur, à l'humidité, etc.).
8. Toujours débrancher le cordon d'alimentation avant d'effectuer n'importe quel type d'entretien.
9. Les condensateurs présents à l'intérieur de l'instrument peuvent toujours être chargés, même si l'instrument est hors tension.
10. Ne jamais tenter de réparer ou de remplacer un composant du système non décrit dans ce manuel sans obtenir de l'aide auprès d'un représentant du service technique.

BONNES PRATIQUES DE LABORATOIRE

Bonne tenue des dossiers

Pour permettre d'identifier et d'isoler les problèmes pouvant survenir avec l'équipement ou la méthodologie utilisés, il est recommandé de tenir correctement des dossiers de toutes les conditions du système (*p. ex.*, % CV sur les temps de rétention et les zones de pics, la forme et la résolution des pics). Il est recommandé tout au moins de conserver pour référence future un chromatogramme d'un échantillon type et d'un mélange standard, bien documenté et accompagné des conditions du système. Une comparaison précise des temps de rétention, des formes et de la sensibilité des pics ainsi que des bruits

de référence peuvent fournir des indices précieux pour l'identification et la résolution de problèmes futurs.

Toxicité chimique

Bien que l'utilisation et l'entreposage dans les laboratoires de grandes quantités de solvants inflammables et toxiques puissent représenter un danger, ne pas négliger les dangers potentiels posés par les échantillons. Veiller particulièrement à lire et à suivre toutes les précautions indiquées pour assurer la ventilation, le stockage, la manutention et l'élimination des solvants et des échantillons. Se familiariser avec les données sur la toxicité et les dangers potentiels associés à tous les produits chimiques en consultant les fiches techniques sur la sécurité des substances (FTSS) du fabricant.

Préparation des échantillons

Toujours considérer la solubilité de l'échantillon dans la phase mobile. La précipitation des échantillons peut boucher la colonne, les tubes et/ou la cellule de dilution, et en limiter le débit. Cette obstruction peut endommager le système de façon irréparable. L'accumulation de particules peut être évitée par la filtration des échantillons à travers des filtres de 0,45 ou 0,2 μm (ou moins).

Caractéristiques des solvants

Un grand nombre de fabricants de produits chimiques fournissent des réactifs de pureté élevée ou de qualité spectrographique dépourvue de toute impureté chimique. La filtration systématique de tous les solvants ou éluants à travers un filtre fluorocarboné de 0,45 ou 0,2 μm (ou moins) avant de les placer dans le réservoir de solvants prolonge de façon significative la durée de vie et l'efficacité des filtres d'entrée, des clapets et des joints d'étanchéité, de l'injecteur et de la colonne. De façon générale, les solvants pour chromatographie liquide sous haute pression ne nécessitent pas de filtration.

Choisir une phase mobile qui est compatible avec l'échantillon et la colonne sélectionnés pour la séparation. Noter que certains solvants sont corrosifs pour l'acier inoxydable. Des versions inertes et biocompatibles des instruments sont disponibles auprès de Thermo Electron.

Dégazage des éluants

Effectuer le dégazage des éluants selon la méthode de dégazage par le vide ou à l'hélium. Une description complète de ces méthodes est disponible dans la documentation fournie séparément avec les accessoires de dégazage.

Élimination des solvants

S'assurer qu'il existe un conteneur pour solvants à éliminer ou tout autre système de vidange au niveau de la table de travail ou au-dessous de celle-ci. La plupart des solvants doivent être éliminés dans des conditions particulières et ne doivent pas être évacués

directement par les canalisations. Respecter la réglementation en vigueur concernant l'évacuation des produits chimiques.

Systèmes à haute pression et fuites

Les systèmes de chromatographie liquide (CL) fonctionnent à des pressions élevées. Les liquides n'accumulent pas de grandes quantités d'énergie car ils ne sont pas hautement compressibles. Par conséquent, le risque d'un danger immédiat causé par les pressions élevées dans un système CL est faible. En revanche, si une fuite survient, il est nécessaire de la réparer le plus rapidement possible. Enfin, il est recommandé à l'opérateur de se protéger en permanence les yeux et la peau lorsqu'il travaille sur un système CL. De plus, il doit toujours mettre le système hors tension et le ramener à la pression atmosphérique avant de procéder à tout entretien.

Informationen zu Sicherheit und Funkentstörung

Wir sind dem Dienst am Kunden und der Sicherheit des Kunden verpflichtet. Diese Geräte entsprechen den Anforderungen für die FCC-Zulassung und für das CE-Zeichen sowie den Bestimmungen der Richtlinie für Niederspannungsgeräte.

Dieses Gerät wurde in einer nach ISO 9001 zertifizierten Fertigungsstätte entwickelt, hergestellt und getestet und hat unser Werk in sicherem Zustand verlassen.



VORSICHT! Dieses Gerät darf nur nach den Vorschriften dieser Bedienungsanleitung benutzt werden. Wenn dieses Gerät auf andere Weise als hier beschrieben benutzt wird, kann dies zu Schäden am Gerät oder zur Verletzung des Bedieners führen.

ERKENNEN VON SICHERHEITS- INFORMATIONEN

Dieses Handbuch enthält Warnhinweise, deren genaue Befolgung Personenschäden, Schäden am Gerät oder Datenverluste verhindern kann. Auf alle derartigen Warnhinweise wird durch Fettschrift und durch

Verwendung der nachfolgenden Symbole gesondert aufmerksam gemacht:



VORSICHT!



**OBERFLÄCHE
HEISS!**



**HOCHSPAN-
NUNG**

Jedes Gerät kann unter bestimmten Umständen gefährlich sein. Lesen Sie daher in jedem Fall die nachstehenden Sicherheitshinweise, und ergreifen Sie die entsprechenden Maßnahmen. Auf dieses Weise sorgen Sie für einen sicheren Betrieb und eine lange Lebensdauer des Geräts.

1. Bevor Sie eines der Gerätemodule einstecken oder das Gerät einschalten, überprüfen Sie in jedem Fall, ob die Nennspannung und die Sicherungen der Netzspannung der örtlichen Stromversorgung entsprechen.
2. Verwenden Sie nur Sicherungen des angegebenen Typs und der angegebenen Amperezahl. Verwenden Sie keine reparierten Sicherungen, und überbrücken Sie die Sicherung nicht.

3. Das mitgelieferte Netzkabel muß in eine Steckdose mit Schutzleiter eingesteckt werden. Wird ein Verlängerungskabel verwendet, muß auch hier der Schutzleiter durchgeführt sein.
4. Verändern Sie nichts an den externen oder internen Schutz- bzw. Erdungskontakten. Wenn Sie sich an diesen zu schaffen machen oder sie unterbrechen, können Sie sich selbst und andere gefährden, oder das Gerät könnte beschädigt werden.



VORSICHT! Das Gerät ist bei der Auslieferung vorschriftsmäßig geerdet. Es brauchen keine Veränderungen an der elektrischen Verkabelung oder am Gerätechassis vorgenommen werden, um einen sicheren Betrieb zu gewährleisten.

5. Nehmen Sie das Gerät nie mit geöffnetem Gehäuse in Betrieb, da dies zu irreparablen Schäden führen kann.
6. Schalten Sie das Gerät nicht ein, wenn Sie den Verdacht haben, daß an der Elektrik möglicherweise Schäden eingetreten sind. Ziehen Sie in diesem Fall den Netzstecker heraus, und lassen Sie das Gerät von einem Kundendiensttechniker untersuchen. Versuchen Sie bis zu dieser Untersuchung keinesfalls, das Gerät in Betrieb zu nehmen. (Eine Beschädigung der Elektrik kann z.B. eingetreten sein, wenn das Gerät äußere Schäden aufweist oder unter problematischen Umständen transportiert wurde.)
7. Schäden können auch eintreten, wenn das Gerät längere Zeit unter ungünstigen Umständen gelagert wurde (z.B. unter der Einwirkung von Hitze oder Wasser).
8. Ziehen Sie vor allen Wartungsmaßnahmen immer zuerst den Netzstecker aus der Steckdose.
9. Auch wenn das Gerät abgeschaltet ist, können die im Inneren befindlichen Kondensatoren nach wie vor unter Spannung stehen.
10. Versuchen Sie niemals, Gerätekomponenten zu reparieren oder auszutauschen, die nicht in diesem Handbuch beschrieben sind, ohne einen Kundendiensttechniker zu Rate zu ziehen.

GLP-VORSCHRIFTEN (GOOD LABORATORY PRACTICES)

Ordnungsgemäße Aufzeichnungen

Damit Probleme mit Geräten oder Methoden erkannt und eingegrenzt werden können, empfehlen wir Ihnen, ordnungsgemäße Aufzeichnungen sämtlicher Gerätezustände (z.B. % RSDs zu Retentionszeiten, Kurvenflächen, Kurvenformen und Auflösung). Archivieren Sie als Minimum ein Chromatogramm einer typischen Probe und

einer Standardmischung mit umfassender Dokumentation der Systembedingungen zum späteren Vergleich. Ein sorgfältiger Vergleich von Retentionszeiten, Kurvenformen, Empfindlichkeitswerten und Hintergrundrauschen liefert wertvolle Hinweise für den Fall, daß zu einem späteren Zeitpunkt Probleme auftreten und eingegrenzt und behoben werden müssen.

Chemische Toxizität

Die großen Mengen an toxischen oder brennbaren Lösungsmitteln, die im Labor verwendet und aufbewahrt werden, können ein erhebliches Gefahrenpotential darstellen, doch darf man hierüber nicht die mögliche Gefährdung durch die Proben selbst vergessen. Achten Sie insbesondere darauf, sämtliche Warnhinweise hinsichtlich ausreichender Belüftung, Lagerung, Handhabung und Entsorgung von Lösungsmitteln ebenso wie von Proben sorgfältig zu lesen und zu befolgen. Machen Sie sich mit den Toxizitätsdaten und den möglichen Gefahren sämtlicher verwendeter Chemikalien anhand der betreffenden Sicherheitsdatenblätter vertraut, die von den Produktherstellern zur Verfügung gestellt werden.

Probenvorbereitung

Überprüfen Sie stets die Löslichkeit der Probe in der mobilen Phase. Durch das Ausfällen von Feststoffen können die Säule, die Leitungen oder die Durchflußzelle verstopfen und damit den Durchfluß hemmen. Durch eine solche Verstopfung können irreparable Schäden am System entstehen. Die Ablagerung von Partikeln läßt sich durch Filtrieren der Proben durch ein Filter mit einer Porengröße von 0,45 oder 0,2 µm (oder weniger) vermeiden.

Anforderungen an das Lösungsmittel

Viele chemische Hersteller bieten eine Produktserie hochreiner Reagenzien in spektroskopisch reiner Qualität an, die frei von chemischen Unreinheiten sind. Die routinemäßige Filtrierung aller Lösungs- und Extraktionsmittel durch ein Fluorkohlenwasserstoff-Filter mit einer Porengröße von 0,45 oder 0,2 µm (oder weniger) vor dem Einfüllen in den Lösungsmittelbehälter verlängert die Lebensdauer der Einlaßfilter, der Ventile und Dichtungen, des Injektors und der Säule beträchtlich. Spezielle HPLC-Lösungsmittel brauchen normalerweise nicht filtriert zu werden.

Wählen Sie eine mobile Phase, die zur Probe und zur für die Separation verwendete Säule kompatibel ist. Dabei ist darauf zu achten, daß Edelstahl durch bestimmte Lösungsmittel korrodiert wird. Reaktionsträge, biokompatible Geräteausführungen werden ebenfalls von Thermo Separation Instruments angeboten.

Entgasen des Lösungsmittels

Lösungs- und Extraktionsmittel sollten entgast werden, und zwar entweder durch Vakuum oder Heliumdurchperlung. Eine umfassende

Beschreibung dieser Techniken finden Sie in dem separaten Handbuch, das dem Entgasungszubehör beiliegt.

Entsorgung von Lösungsmitteln

Sorgen Sie dafür, daß ein Auffangbehälter für Lösungsmittel oder eine andere Auffangvorrichtung in Höhe des Arbeitstisches oder darunter zur Verfügung steht. Für die meisten Lösungsmittel gelten besondere Entsorgungsvorschriften; eine Entsorgung über die Abwasserleitung ist hier nicht zulässig.

Bei der Entsorgung von Chemikalien gleich welcher Art sind die einschlägigen Vorschriften streng zu beachten.

Hochdrucksysteme und Undichtigkeiten

Flüssigchromatographen arbeiten unter hohem Druck. Da Flüssigkeiten kaum komprimierbar sind, können sie nicht viel Energie speichern. Dementsprechend stellt der hohe Druck in einem Flüssigchromatographen auch kaum eine unmittelbare Gefahr dar. Jedoch sollten auftretende Undichtigkeiten umgehend beseitigt werden. Schließlich ist noch zu empfehlen, bei der Arbeit mit einem Flüssigchromatographen stets Augen und Haut zu schützen und vor allen Wartungsarbeiten darauf zu achten, daß das Gerät abgeschaltet und druckfrei gemacht wurde.

Manual Conventions

This manual uses several conventions. Among them are menu displays, text conventions (brackets, slashes, etc.), standard words, and several different icons.

DISPLAYS

We will depict the two-line display as shown below. Note that in menu illustrations, the triangular cursor location is indicated by a caret (>).

>FILES	QUEUE	TESTS
COMMANDOS	OPTIONS	

A two-line menu display

Frequently the two lines shown on the display are only part of a longer menu which you would see by pressing the down-arrow key. In this manual, menus having more than two lines are represented as follows:

Edit File	1
File Name	

>Solvent Program	
Options	
Timed Events	

A menu longer than two lines

TEXT CONVENTIONS

Three typographic conventions are used to differentiate between keys, menus and fields.

Brackets

Brackets, [], indicate instrument keys. For example: Press the [MENU] key.

Slashes

Slashes, / /, are text conventions used around menu choices. For example: From the Main Menu, select /FILES/, /Edit/.

Capitalization

Capitalization is used to make field and menu names appear just as they do on the display. Generally the first letters of field names are capitalized. For example: In /Solvent Program/ go to the Flow field.

STANDARD WORDS

We have also standardized the meanings of two words: "select" and "enter."

select

The word "select" is used when you need to choose from among available options. For example, to select a particular menu choice, you would move the cursor to the appropriate choice and press [ENTER]. To "select" a field entry, move the cursor to the appropriate field and use the [+] and [-] keys to scroll to the desired choice.

enter

The word "enter" is used when you need to specify individual alphanumeric digits. To "enter" a particular value, move the cursor to the field and use the [+] and [-] keys to increment or decrement each digit in the field until the desired value or letter appears.

ICONS

This manual uses the following five icons to alert you to various situations. Each is called out by an icon in the left margin.



Caution!

A caution alerts you to situations that could result in personal injury. It also tells you how to avoid them.



High Voltage!

This icon alerts you to the presence of high voltage and to the potential injury that could occur from electrical shock were you to come in contact with a specific instrument area or component. It also tells you how to avoid contact with the high-voltage areas in your instrument.



Hot Surface!

This icon alerts you to potential injury that could occur from coming in contact with a heated surface or area on or in an instrument. It also tells you how to avoid contact with the heated surfaces in your instrument.



Note

Notes alert you to the correct operating or maintenance procedures needed to prevent equipment or data damage. They also alert you to important exceptions, side effects, or unexpected occurrences that may result from certain action(s).



Hint

Hints call out general rules or shortcuts. They specify ways to obtain the best performance and results from your instrument.

1

Installation and Specifications

Introduction

This chapter contains information necessary to install your Thermo Electron, Finnigan SpectraSYSTEM™ or SpectraSERIES P1500, P1000, or P100 pump properly. The step-by-step instructions describe how to set the voltage for your area, how to connect tubing, and how to prime and purge the pump. Use the checklist on the next page to complete pump installation. Be sure you read the Safety Information at the front of this manual before proceeding with any installation. If you have any questions or need further assistance, refer to page iii for the customer support numbers.

Start-up Checklist

This list is a brief summary of tasks that should be completed to install your pump. Complete installation information is contained in this chapter.

- ☐ Inspect your instrument
- ☐ Check for parts shortages
- ☐ Set the voltage
- ☐ Place the pump
- ☐ Connect the power cord
- ☐ Check initial response to power-on
- ☐ Hardwire to eight-pin port, using external function connector, making electrical connection to other SpectraSYSTEM instruments
- ☐ Install kits or accessories
- ☐ Prepare and connect solvents
- ☐ Connect inlet lines
- ☐ Prime with solvent
- ☐ Purge solvent lines
- ☐ Connect to system

This pump was installed by:

(Name)

(Date)

Unpacking

INSPECT YOUR INSTRUMENT

Your pump was shipped in a special container designed to provide excellent protection from routine wear and tear encountered in transit.

After unpacking, inspect your pump and its accessories for missing parts and/or physical damage. If damage is found, notify both the carrier and your sales representative. Please DO NOT return any goods without prior authorization from Thermo Electron.



NOTE: Narrow-bore pumps will have a 3 μ L static mixer included.

The contents of your package varies with the model and options purchased. A basic accessory kit is supplied with each pump and includes the following tools and parts.

The contents of your ship kit is as follows:

- 1 Pump
- 1 *SpectraSYSTEM and SpectraSERIES Isocratic Pumps Reference Manual (A0099-585)*
- 1 Accessory Kit
- 1 Tubing Kit
- 1 Declaration of Conformity

OPTIONS AVAILABLE

A variety of options, kits, and accessories are available for your pump. Refer to Appendix A, *Kits and Parts Lists* for a full description and parts list of each. If you purchased an inert/biocompatible pump, the correct tubing and liquid ends were installed at the factory before shipment.

For a list of all available accessories, upgrades, and kits, see the insert at the front of this manual or contact your Thermo Electron sales representative. Note that all upgrades require installation by Thermo Electron.



NOTE: The pump features a bypass valve pre-installed as standard equipment.

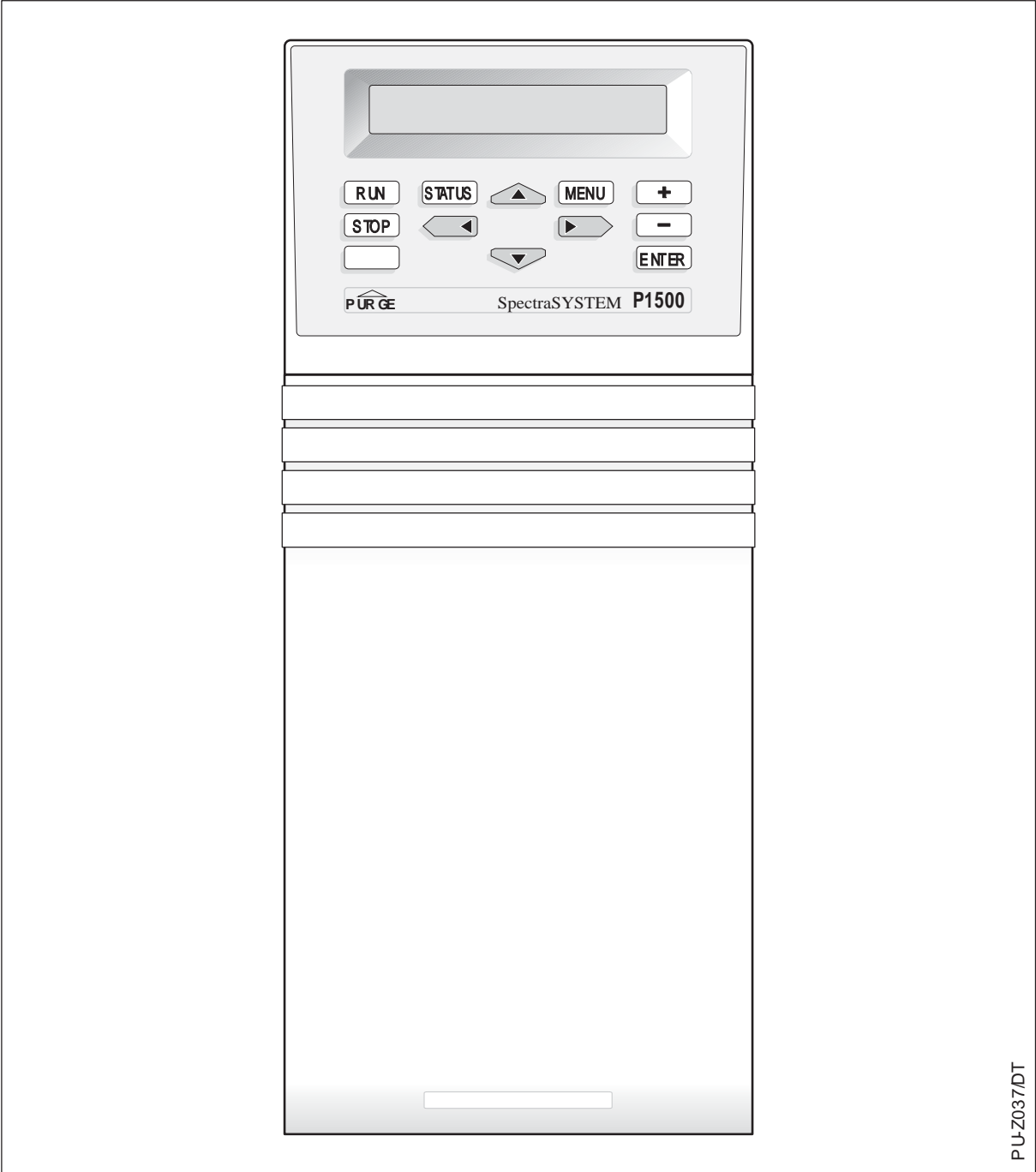


Figure 1.1 A SpectraSYSTEM pump

Installation

LIFTING AND CARRYING THE PUMP

The correct way to carry the pump is to use the two hand holds, one located underneath the front of the pump, and the other at the top of the back, near the power switch. Grasp the pump well underneath the front when lifting and carrying.

SETTING THE VOLTAGE

All pumps are configured at shipment for 230 VAC (50/60 Hz) operation. Depending upon the country of use, you may need to change the voltage setting.



NOTE: Check the position of the voltage select barrel located on the rear panel (Figure 1.2). If the indicated voltage setting is not consistent with your area, DO NOT CONNECT THE POWER CORD!

The voltage setting can be easily modified as follows:

1. Remove the tape label covering the power entry receptacle.
2. Ensure that the power cord is *not* connected to the pump.
3. Use a small, flat-blade screwdriver to pry open the power selector/fuse cover to expose the voltage selector barrel. You will probably hear the top edge of the cover snap as it is pried open.
4. Remove the plastic selector barrel by pulling it straight out.
5. Rotate the barrel until you see the desired voltage (either 115 VAC or 230 VAC) and insert the barrel back into the housing with the desired voltage visible.
6. Firmly snap the housing cover back in place. Be sure that the selected voltage is visible in the voltage window (Figure 1.3).



HINT: Use two thumbs to push up on the top half of the cover as you push in. The voltage selected will be visible through the window.

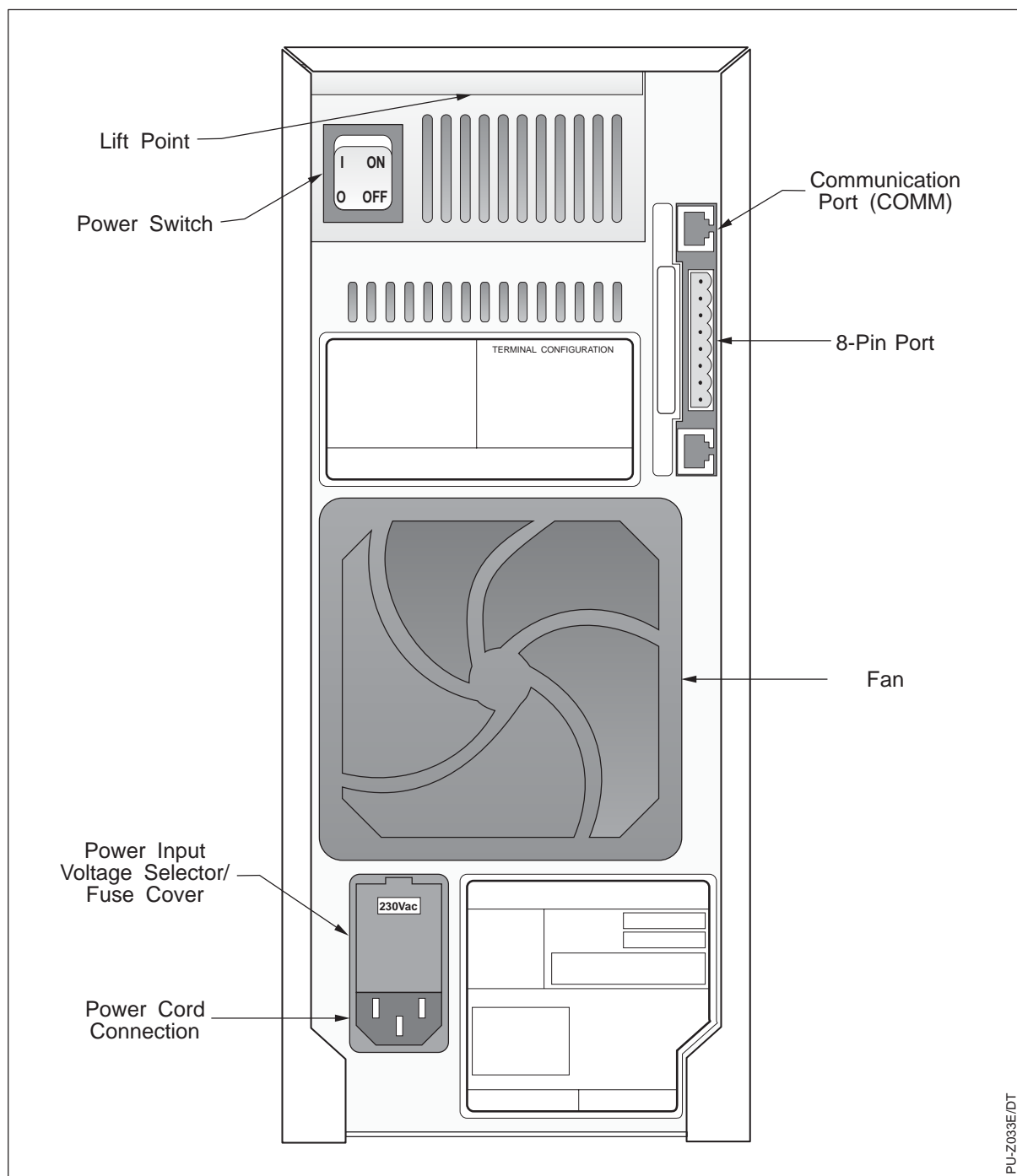


Figure 1.2 Rear panel

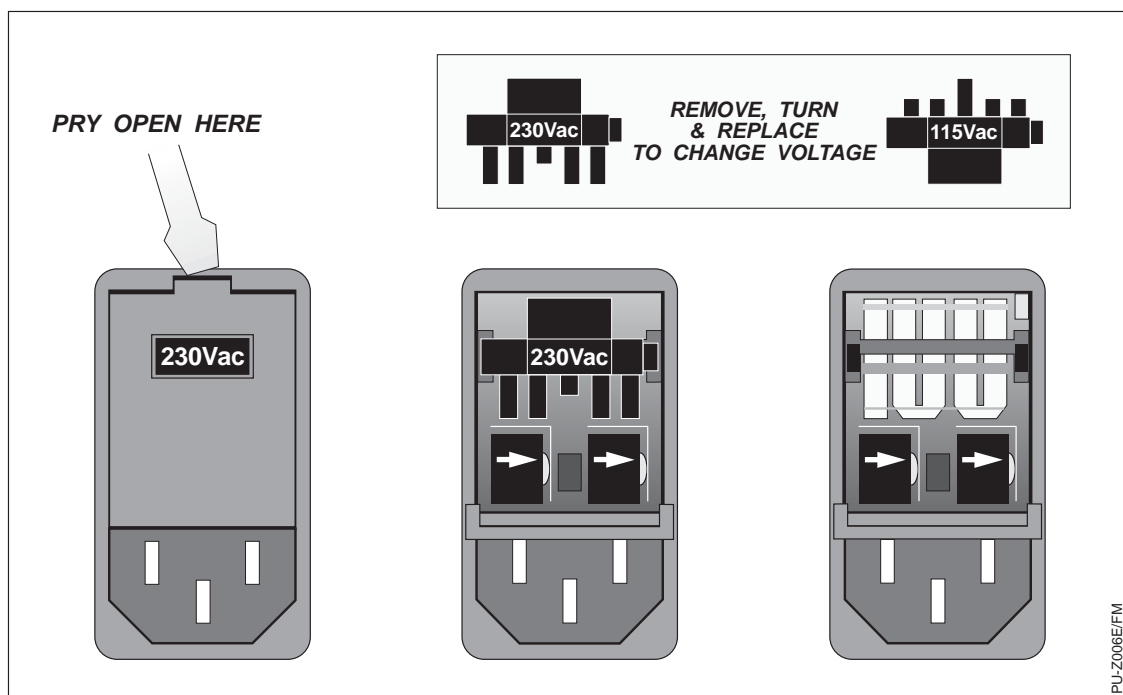


Figure 1.3 Power selector/fuse cover, closed, with "voltage window." The opened power selector/fuse cover, with barrel selector removed

PLACING THE PUMP

The pump weighs approximately 38 pounds (18 kg) and requires at least 6 inches (16 cm) of bench width and at least 19 inches (48 cm) of bench depth. If used with a manual injector bracket, the pump requires 9 inches (23 cm) of bench width. The pump needs a space at least 15 inches (38 cm) high.

Place the pump on a level surface. Leave 2 inches (6 - 7 cm) behind the instrument for good air flow and access to electrical connections. Keep the pump away from heating and cooling ducts, and avoid exposing the pump to direct sunlight. The pump should be placed to the far left of your LC system if it is used with a SpectraSYSTEM autosampler or detector.

CONNECTING THE POWER CORD

Attach the AC power cord. (see the insert at the front of this manual.) Plug the power connector into an appropriately grounded power outlet.



NOTE: For safe operation and optimum performance, the pump must be connected to a properly grounded power receptacle.

CHECKING INITIAL RESPONSE TO POWER ON

Turn on the power by pressing the power switch (Figure 1.2). With the pump's front panel facing you, the power switch is located in the back, on the upper right-hand side. The fan starts and a display similar to Figure 1.4 appears for one second.

VERSION x.yy.zz

Figure 1.4 A brief power-up message

If this message does not appear, double-check the electrical connections and try turning on the pump once more, watching the screen closely. If the message still does not appear, contact your Thermo Electron representative.

Next, the display shows the Status Screen, similar to Figure 1.5.

Status	Flow	PSI
STOP	1.00	154 ▼

Figure 1.5 P1000 and P100 Status Screen



NOTE: The P1500's Status Screen differs slightly from the figure above.

HARDWIRING EXTERNAL EVENTS

Pin 6 of the eight-pin port on the back of the pump (Figure 1.2) allows you to control another device, such as a column switching valve or fraction collector. If you plan to control such a device or instrument using the pump's Timed Events feature, insert the external function connector into the eight-pin port.

The pins are labeled both on the port and on the external function connector. Ensure that the pin numbers match whenever plugging the connector into the port.

Hardwire your device using the 4-connection cable. Loosen pin 6's small screw, insert the wire, then tighten the screw.

You must also insert the external function connector if you use a SpectraSYSTEM and SpectraSERIES autosampler. More information about making hardwire connections to an autosampler is found on page 17, and in the *SpectraSYSTEM and SpectraSERIES Autosamplers Reference Manual*.

Pin assignments for the eight-pin port are shown in Table 1.1.

Table 1.1 Eight-pin port pin assignments

<u>Pin #</u>	<u>Assignment</u>
1	READY (Output)
2	+5 VDC 100 mA MAX
3	GROUND
4	PRESSURE 0.1 V/1000 PSI
5	STOP (Input)
6	TIMED EVENT (Output)
7	RUN (Input)
8	INJ HOLD (Output)

All outputs (pin 1, pin 6, and pin 8) are open-collector type, capable of sinking up to 30 mA at a maximum of 30 VDC.

INSTALLING KITS OR ACCESSORIES

Refer to Appendix C for complete instructions for installing the Manual Injection Valve Bracket (column holder).

PREPARING AND CONNECTING SOLVENTS

If you did not purchase a solvent degassing apparatus or solvent bottles from Thermo Electron, skip this section. Continue with *Connecting Inlet Lines* on the next page.

Solvent Bottles

Prepare your solvent bottle(s) as follows:

1. Rinse the bottle(s) with LC-grade solvent to remove any dust.
2. Fill the bottle(s) with appropriate LC-grade solvent(s).
3. The bottle caps are pre-assembled to include an inlet line and filter. Ensure that each filter is tightly assembled to its fitting, and the filter fitting is firmly attached to the inlet line. Place the solvent filter/inlet line into each bottle, making sure that the inlet filter rests on the bottom of the bottle. Cap the bottle.
4. Attach the appropriate label to each solvent bottle cap to identify it.
5. Run vent lines from each bottle to an appropriate exhaust apparatus.

Degassing

There are two recommended methods for degassing solvents for use with your pump: vacuum degassing and helium degassing.



NOTE: Solvent degassing is recommended for isocratic applications because it results in improved detector performance.

If you purchased a Thermo Electron degasser, set up your degasser as described in the degasser manual and continue the pump installation when you have a supply of degassed solvent available.

CONNECTING INLET LINES

Refer to Figure 1.6 when connecting the inlet lines.

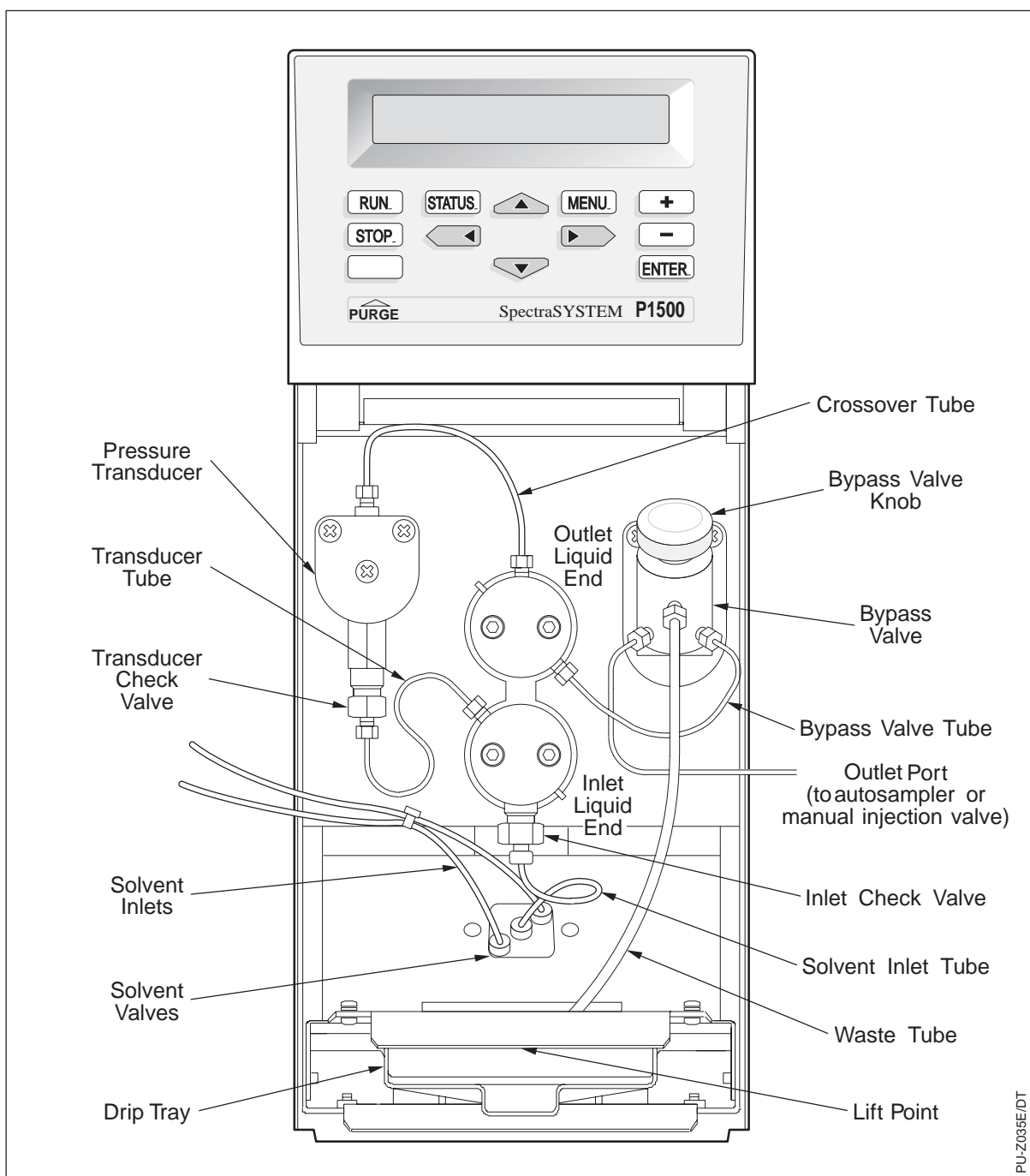


Figure 1.6 Front panel, cover removed

The P1000 and P100 have only one inlet; the P1500 has two. Connect the pump's inlet line(s) (Figure 1.6) to your solvent supply.

BYPASS VALVE

The bypass valve is shown in Figure 1.7. Do not attach a line to the waste/prime port (the middle port) now, but have the solvent waste tube (provided in the accessory kit) ready. You will attach the tube to the waste/prime port after priming the pump.

PRIMING AND PURGING

The P1500, P1000, and P100 pumps are shipped with methanol in the pump heads and connecting tubing. If the first solvent you'll use is not miscible with methanol, first prime the pump with an intermediary solvent. Once primed, you should purge the pump to remove any air bubbles.



HINT: It is best to prime the pump initially with methanol to fully wet all internal surfaces. Priming with 100% water can often result in trapped air due to the high surface tension of the water. Trapped air affects flow stability.

Priming the Pump

To prime the pump with your solvent and simultaneously flush the methanol out, you will need the 20 mL priming syringe and Luer adapter found in the accessory kit. You will also need a solvent waste container.

1. Remove the waste line from the waste/prime port of the bypass valve, if connected.
2. Install the Luer adapter to the waste/prime port (Figure 1.7). Tighten to finger-tight, then wrench tighten approximately 1/4-turn. (This allows the priming syringe to be attached and detached conveniently.)

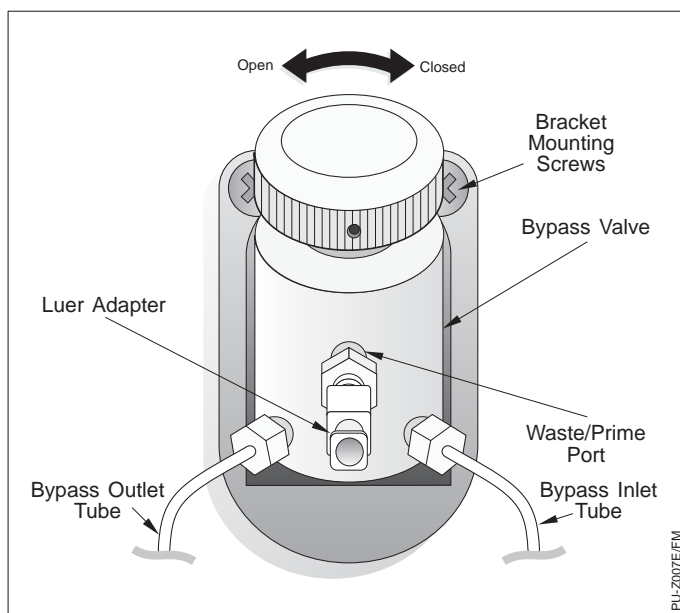


Figure 1.7 Bypass valve with Luer adapter connected

3. Make sure that the 20 mL Luer-tip priming syringe is fully depressed. Connect the syringe to the adapter in the waste/prime port (Figure 1.9 and Figure 1.10) twisting the syringe slightly to make a leak-free connection.
4. Position a solvent waste container nearby to collect the syringe discharge, since two or three syringe volumes may be needed to prime the pump. Make sure that all tube connections are airtight.

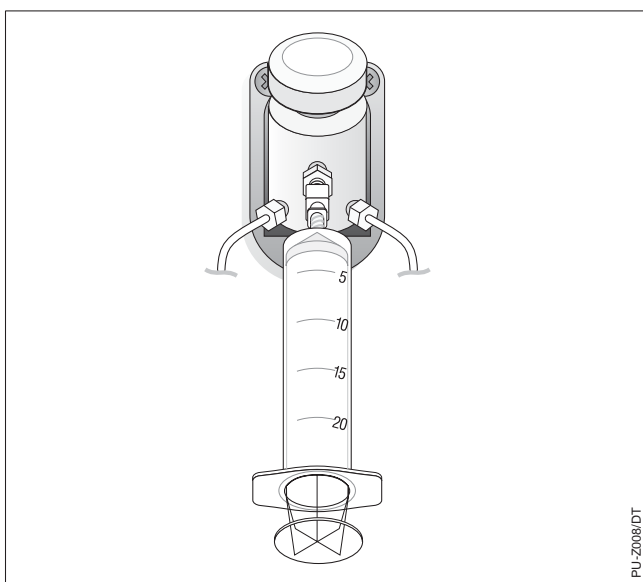


Figure 1.8 Bypass valve with syringe attached

5. Open the bypass valve by turning the knob fully counterclockwise.



NOTE: Solvents flow through the pump when the pump is purging or when a file is initialized (loaded as a run file).

6. Turn on power to the pump (if it not already on) and press [PURGE]. The P1500's Purge Menu differs from the P1000 and P100 (Figure 1.9). If you have a P1500, the cursor should appear under the word Purge on the display. Press [+] to select the solvent (A or B).



NOTE: Purging starts whenever the cursor is moved out of the Purge Menu Time field by pressing [ENTER].

Purge	Flow	Time
A	1.00	0.0

Figure 1.9 The Purge Menu (P1500)

Purge	Flow	Time
	1.00	0.0

Figure 1.10 The Purge Menu (P1000 and P100)



NOTE: The Flow field may be labeled Pres instead of Flow, depending on the purge mode that is set.

7. *For analytical applications:* Move the cursor to the Flow field. Set the flow rate to 10 mL/min. If the purge mode is pressure, set the pressure to 1000 psi (69 bars, 7 Mpa).
For narrow-bore applications: Move the cursor to the Flow field. If the purge mode is pressure, set the pressure to 1000 psi (69 bars, 7 Mpa).
8. Move the cursor to the Time field, then press [ENTER]. You will hear the pump's motor start.
9. Slowly pull the syringe plunger back to create a small vacuum in the solvent lines that will draw the solvent from the solvent bottles (or the vacuum degasser) into the pump heads. *Do not draw back so far as to remove the plunger from the syringe barrel!*

If more than one draw is necessary to prime the pump, (*i.e.*, the syringe fills with air before solvent enters the pump heads), press [STOP], close the bypass valve (turn clockwise), remove the syringe, and depress the plunger. Reconnect the syringe, open the bypass valve, press [PURGE], enter a flow rate or time, press [ENTER], and finish drawing the solvents into the pump as described at the beginning of this step.

If you notice a leak in one of the fittings, or need to stop the solvent flow, press [STOP]. This will immediately stop flow through the pump.

10. When solvent steadily appears in the syringe and no air bubbles are present, press [STOP], then close the bypass valve.
11. Gently remove the syringe and empty it into the solvent waste container.
12. Remove the Luer adapter from the valve port and store it, along with the priming syringe, for later use.
13. Connect the solvent waste line to the waste/prime port of the valve and tighten to finger-tight. Route the waste tubing to an appropriate solvent waste container.

Purging the Pump

With the pump primed, purge the lines containing your chosen solvents as follows:

1. Ensure that the solvent inlet filters inside each solvent bottle are in a vertical position so that air within the filter will not be trapped.
2. Fully open the bypass valve.
3. We suggest that you initially purge the lines with a volume of 10 mL.

If you have a P1000 or P100, follow the steps below to begin the purge operation:

- a) Press [PURGE] to reach the Purge Menu (Figure 1.9 and Figure 1.10). If desired, change the purge mode by pressing [MENU], /OPTIONS/, /More/, Purge Mode. (The words in the top line of the display will change, depending on your purge mode preference.)
- b) Move the cursor to the Flow or Pressure field.
For analytical applications: If the purge mode is Flow, enter a flow of 10.00 mL/min. [If pressure, set to 1000 psi (69 bars, 7 Mpa).]
For narrow-bore applications: If the purge mode is Flow, enter a flow of 5.00 mL/min. [If pressure, set to 1000 psi (69 bars, 7 MPa).]
- c) Press [ENTER] and enter a time of 1.00 minute.
- d) Press [ENTER], the pumps motor will start. The pump will automatically stop purging after one minute and then initialize. After you have completed the purge, be sure to close the purge valve.

Purge	Flow	Time
	1.00	1.00

Figure 1.11 The Purge Menu with flow and time values entered (P1000 and P100)

If you have a P1500, follow the steps below to begin the purge operation:

- a) Press [PURGE] to reach the Purge Menu (Figure 1.11).
- b) Select the solvent of choice in the Purge field, then press [ENTER]. If the purge mode is Flow: enter a flow of 10.00 mL/min. [If Pres, set to 1000 psi (69 bars, 7 MPa).]
- c) Press [ENTER] and enter a time of 1.00 minutes. Ten milliliters should be enough volume to remove any trapped air and ensure that the pump and tubing are cleansed of any contaminants.
- d) Press [ENTER]. The pump will automatically stop purging after one minute and then initialize.

Purge	Flow	Time
A	10.00	1.00

Figure 1.12 The P1500's Purge Menu with flow and time values entered

If you choose to purge without setting a time in the Time field, you can stop the purge by pressing [STOP]. This will immediately stop flow through the pump.

4. When you complete the purge and the pump stops, close the bypass valve.

LC System Connections

Once the pump is purged, you can plumb it to the rest of your chromatographic system. Figure 1.6 and Figure 1.7 illustrate the bypass valve, showing the pump's outlet. Using a pre-cut piece of stainless steel tubing (or PEEK tubing if inert/biocompatible), connect the outlet to your autosampler or manual injection apparatus.

If you are using a manual injector valve from Thermo Electron, refer to Appendix C for complete information for installing the injector valve bracket.

If you are using a SpectraSYSTEM or SpectraSERIES autosampler, the pump sends a ready signal to the autosampler through pin 1, and receives a stop signal from the autosampler through pin 5. In addition, the ground contact (pin 3) must also be connected to the autosampler's ground contact. For complete information on how to make these connections, refer to the *SpectraSYSTEM and SpectraSERIES Autosamplers Reference Manual*, Chapter 1. The table below summarizes the hardwire connections necessary between a SpectraSYSTEM autosampler and pump.

Table 1.2 Pump connections to a SpectraSYSTEM or SpectraSERIES autosampler

<u>PUMP</u>				<u>AUTOSAMPLER</u>	
<i>READY (Output)</i>	Pin 1	to	Pin 5	<i>PUMP READY</i>	
<i>GROUND</i>	Pin 3	to	Pin 1	<i>GROUND</i>	
<i>STOP (Input)</i>	Pin 5	to	Pin 3	<i>PUMP STOP</i>	
<i>RUN (Input)</i>	Pin 7	to	Pin 4	<i>GRAD START</i>	
<i>INJ HOLD (Output)</i>	Pin 8	to	Pin 7	<i>INJ HOLD</i>	

Performance Verification

After installing your SpectraSYSTEM or SpectraSERIES pump, it is suggested that you run a performance test to verify that the instrument is working properly. Common tests for pumps include flow accuracy and precision. Procedures for these performance tests are described below.

FLOW ACCURACY

There are many ways to test pump flow accuracy: graduated cylinder vs. time, calibrated flow meter, or gravimetric vs. time. The procedure below describes how to measure the flow accuracy and precision using a gravimetric procedure. In general, you will set the pump to a flow rate, collect eluant for a specified time in a weighed flask, and determine the flow rate and accuracy. The actual flow rate can also be used to calibrate your pump. This test will take approximately 20 minutes.

Test Setup

Column or flow restrictor: To deliver c.a. 1000 psi backpressure

Flow Rate: Any flow rate to be tested for accuracy

Mobile phase: MeOH or other appropriate mobile phase

Experimental

Use the following steps to calculate the flow rate accuracy:

1. Prepare the desired mobile phase for the accuracy test.
2. Filter and degas the mobile phase.
3. Purge the pump and the column or flow restrictor being used.
4. Set the pump at the desired flow rate and start.



HINT: A volumetric flask is ideal because it helps to minimize evaporation. Also, wrap tube and top of flask with aluminum foil to help eliminate evaporation.

5. Weigh a clean flask capable of holding approximately 10 minutes of volume at the set flow rate. Include top and any other items attached to flask.
6. Record this weight.
7. Place the flask under the flow stream from the pump and start timing.



HINT: Use a stopwatch for the timing portion of the test. The more accurate the stopwatch the better the results.

8. Collect the pump's eluant for 20 minutes.
9. Re-weigh the flask and record.

10. Calculate the actual flow rate:

$$[(\text{Weight}_{\text{full}} - \text{Weight}_{\text{empty}}) / \text{Density}] / \text{Time} = \text{Flow Rate}$$

11. Set a flow rate of 0.5 mL/min using MeOH as the mobile phase.

$$\text{Flow Rate} = [(22.8577 \text{ g} - 14.8858 \text{ g}) / 0.7894 \text{ g/mL}] / 19.9687 \text{ min}$$

$$\text{Flow Rate} = [(7.9719 \text{ g}) / 0.7894 \text{ g/mL}] / 19.9687 \text{ min}$$

$$\text{Flow Rate} = 10.0987 \text{ mL} / 19.9687 \text{ min}$$

$$\text{Flow Rate} = 0.506 \text{ mL} / \text{min}$$

12. Calculate the flow accuracy of the pump:

$$\text{Flow Accuracy} = 100 \star |(\text{FR}_{\text{set}} - \text{FR}_{\text{actual}}) / \text{FR}_{\text{set}}|$$

$$\text{Flow Accuracy} = 100 \star 0.006 \text{ mL} / \text{min}$$

Example

Using the data from step 10 gives the following results:

$$\text{Flow Accuracy} = 100 \star |(0.5 \text{ mL/min} - 0.506 \text{ mL/min}) / 0.5 \text{ mL/min}|$$

$$\text{Flow Accuracy} = 100 \star (0.006 \text{ mL} / 0.5 \text{ mL/min})$$

$$\text{Flow Accuracy} = 1.2\%$$



HINT: For flow rates above 0.5 mL/min, it is best to install an in-line 100 μL mixer replacing the 3 μL mixer.

Specification

Typical results for flow precision are less than 1% (absolute). However, results can vary based on temperature, mobile phase, and flow rate.



HINT: When using gravimetric measurements, other correction factors may be used to increase the accuracy of the measurements. These include evaporation rate and the net buoyant effect.

FLOW PRECISION

Flow precision checks the reproducibility of the flow rate. This procedure is simply running the accuracy test 7 or more times and calculating a percent relative standard deviation. This procedure will require at least a couple of hours.

Test Setup

Set up the flow precision test above to perform 7 or more replicate runs.

Column or flow restrictor: To deliver c.a. 1000 psi backpressure

Flow rate: Any flow rate that accuracy is to be tested

Mobile phase: MeOH or other appropriate mobile phase



HINT: For flow rates above 0.5 mL/min, it is best to install a 100 μ L mixer in-line replacing the 3 μ L mixer.

Experimental

1. Repeat the flow accuracy test above for 7 or more replicate runs.
2. Determine the flow rate for each replicate.
3. Determine the average flow rate for the replicate runs.
4. Determine the standard deviation for the replicate runs.
5. Determine the relative standard deviation for the replicate runs.

Using the following example values:

Average = 0.502 mL/min

Standard Deviation = 0.004

Relative Standard Deviation (RSD) = $100 \times \text{SD}/\text{Average}$

Yields:

$\text{RSD} = 100 \times (0.004/0.502 \text{ mL/min})$

$\text{RSD} = 100 \times 0.00797$

$\text{RSD} = 0.797\%$

Specification

Typical results for flow precision are less than 1% (absolute). However, results can vary based on temperature, mobile phase, and flow rate.

Specifications

P1500, P1000, P100:	Isocratic pumps utilizing a dual in-line and floating piston design, bayonet-mounted liquid ends, and patented ceramic check valves.
Physical:	14.5" (37 cm) x 6" (15 cm) x 18.5" (47 cm) (H x W x D) 38.6 lb. (18 kg)
Wetted Surfaces:	316 stainless steel, analytical and narrow-bore PEEK, semi-prep other surfaces for all pumps: Teflon®, Tefzel®, sapphire, polyethylene
Delay Volume:	< 800 µL, analytical < 500 µL, narrow-bore (P1500, P1000 only)
Flow Rate Range:	0.01 - 10.00 mL/min, analytical or narrow-bore pumps 0.01 - 30.00 mL/min, semi-prep PEEK pumps
Flow Accuracy:	< 1% at 1.0 and 4.0 mL/min, analytical or semi-prep < 1% at 0.2 and 1.0 mL/min, narrow-bore
Flow Precision:	Typically < 0.2% at 0.5 mL/min or greater
Pressure Range:	42 MPa or 420 bar or 6000 psi, analytical or narrow-bore 28 MPa or 280 bar or 4000 psi, semi-prep
Pressure Pulsation:	Typically < 1.0% at 1 mL/min
Method Files:	4 method + 1 Shutdown, P1500 1 method + 1 Shutdown, P1000/P100
Communications:	Remote Inputs: Ready, Run, Stop Timed Events Analog Pressure output RS-232 (P1500 and P1000 only)
Power:	115/230 VAC, 50/60 Hz 1.2/0.6A 200 VA
Safety/EMC Compliance:	CSA, TÜV, FCC, CE Mark, EMC, Low Voltage Directive

2

A Quick Example

Introduction

This chapter gives you the chance to become familiar with your pump's screens and menus. It provides you with the three basic rules you'll need for using your pump menus. It also introduces you to the instrument's command center and describes the conventions we'll use in this manual. In this chapter you will set up a few typical options, purge your solvent lines, and run a flow stability test.

If you already feel comfortable with how to move through menus and displays, just scan this chapter and proceed to Chapter 3. If you want more practice with the pump menus, follow the instructions in this chapter closely. Since the object of this chapter is to become familiar with the keypad and menus, we won't provide detailed explanations of the examples shown. More information can be found in one of the succeeding chapters.

If you haven't installed your pump, be sure that you read the Safety Information at the front of this manual and follow the procedure in Chapter 1.

Throughout our explanations, we encourage you to explore the general architecture of the instrument's menus and screens. Use the appropriate Menu Tree Card in the front pocket of your manual as your guide if you wish.

Learning Your Way Around

AS EASY AS 1-2-3!

It's easy to learn your way around a SpectraSYSTEM or SpectraSERIES pump. Just remember these three easy rules:

1. The ([^], [v], [<], [>]) move the cursor in the direction printed on the key.



HINT: Press [MENU] to jump quickly to the top of the menu structure.

2. The shape of the cursor determines how you make a selection:
 - If a triangular cursor appears, press [ENTER]
 - If a blinking square cursor appears, press the [+] or [-] keys to scroll up or down through preset choices, or to increase or decrease alphanumeric entries.
3. There are four ways to accept (and automatically save) an entry. Just move the cursor out of the field by any of the following methods:
 - Pressing [ENTER]
 - Using the arrow keys
 - Pressing [MENU]
 - Pressing [STATUS]



NOTE: If you can't leave a menu, either errors are present or you haven't filled in all the necessary entries.

VISUAL CLUES ON DISPLAY

Several visual clues help you move through the pump's menus and enter values.

1. Top-level menu choices are displayed in all-capital letters; lower-level menu choices are displayed in upper- and lower-case letters.
2. A field's square cursor changes to an underscore cursor when you're scrolling through preset choices or entering numerical values and characters.
3. A solid down-arrow (▼) on the right side of some displays indicates that the current menu continues on additional screens. To access additional menu lines, press the down-arrow key, [v].
4. The last line of a longer menu is frequently a blank line (without a solid down-arrow).

Instrument Control

Take a look at the keypad and two-line display located on the front panel (Figure 2.1). This is the command center from which you'll access menus and control the instrument's operations. A brief explanation of the keys and the main menus and screens follows.

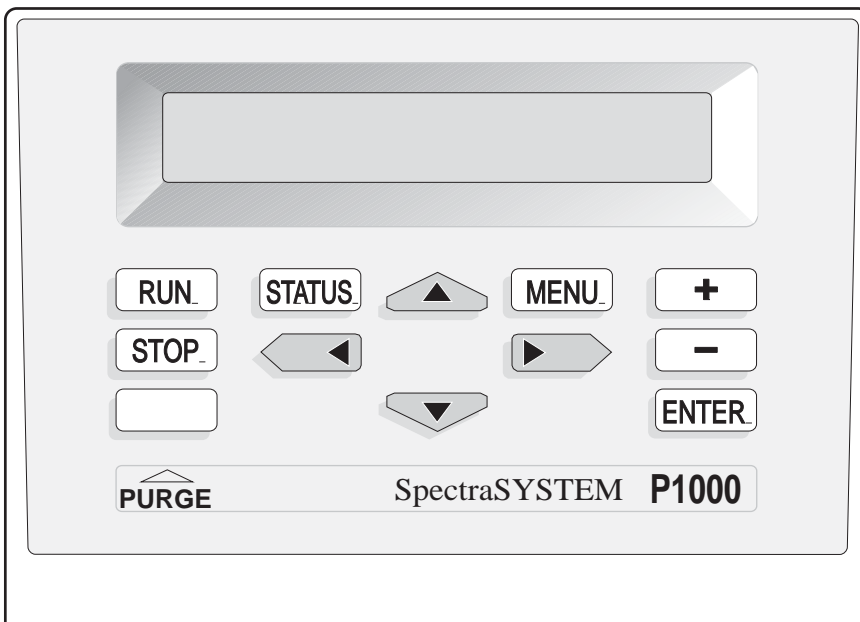


Figure 2.1 The P1000 pump

NOTE: The keypads of the P100 and P1500 pumps are identical.

The keypad of each SpectraSYSTEM or SpectraSERIES instrument consists of twelve keys. Four keys directly control the instrument's operation: [RUN], [STOP], [STATUS], and, on the pump, a blank key called [PURGE]. The remaining keys ([MENU], [ENTER], [^], [v], [<], [>], [+], [-]) either access commands or are used to set parameters and move around the display. The function of each is explained below.

[RUN]

Generally, pressing [RUN] starts a run or sets up the conditions specified for the beginning of a run.

The specific [RUN] operation depends on the instrument's state:

1. If the pump's state is STOP, pressing [RUN] automatically prepares the last file loaded (the P1000 has only one file) to be run and sets the pump to the conditions specified for the start of the run (t_0 conditions).

2. If the pump's state is READY, (that is, the initial conditions already exist), pressing [RUN] starts the run (P1500 only).

[STOP]

Pressing [STOP] halts an operation in progress. (Specifically, the [STOP] key aborts a run in progress by stopping solvent flow through the pump.)

[STATUS]

Pressing [STATUS] displays Figure 2.4 The Status Screen (P1500) and Figure 2.5. The keypads of the P100 and P1500 pumps are identical (Figure 2.1). From the status screen, you can monitor the run in progress. You can also access the Status Menu. See page 28 for more information.

[PURGE]

The unlabeled key is the only variable key in the whole SpectraSYSTEM family. On the pump, the blank key is the [PURGE] key. The key's name appears on the nameplate below the key.

The [PURGE] key brings the PURGE Screen to the display. Purge parameters can be changed and the purge operation started from this display. Refer to *Purging Solvent Lines* in Chapter 3 and to *Priming and Purging the Pump* in Chapter 1 for complete information.

[MENU]

Pressing [MENU] displays the Main Menu (Figure 2.2 and Figure 2.3). Each main menu item is explained in detail in the rest of this manual. For FILE(s) and COMMANDS see Chapter 3, for QUEUE, OPTIONS and TESTS (see Chapter 4).



NOTE: The P100 and P1000 Main Menu choices are *FILE*, *OPTIONS*, and *TESTS*.

[ENTER]

Pressing [ENTER] accepts a selected choice or menu entry. The [ENTER] key also advances the cursor to a new field, either on the same line of the display or in the line below.

[^], [v], [<], and [>]

Pressing any arrow key (up, down, left, or right) moves the cursor in the direction indicated on the key. If the cursor is on the first or the last line of a menu, the up- and down-arrow keys move you "up" or "down" in the menu structure.

[+] and [-]

Pressing the [+] and [-] keys scrolls you through a field's available choices or changes the value of alphanumeric entries. Holding down either key will continuously scroll the list of choices forward or backward until you release the key.

In fields that require numeric entries, the value of the selected digit is increased or decreased by one unit each time you press the [+] or [-] key. In fields that accept *either* numeric or alphabetic entries, such as the File Name field, the [+] and [-] key scroll through the alphabet from A to Z, then through the numbers 0 to 9, and finally to a slash, hyphen and blank space.

In other fields, the [+] key advances you through a preset list of choices while the [-] key takes you back through the list.

MENUS AND SCREENS

Your pump has two kinds of displays: menus and screens. Menus require you to make selections or enter specific values. Screens display information that cannot be edited. The Menu Tree in from pocket of your manual illustrates the structure and content of the pump's menus and screens.

Main Menu

Figure 2.2 for the P1500 and Figure 2.3 for the P1000 and P100 is the top level of the menu structure. The Main Menu gives you access to several other menus. In the P1500, there are five menus: FILES, QUEUE, TESTS, COMMANDS, and OPTIONS. In the P1000 and P100, there are three menus: FILE, TESTS, and OPTIONS. To see the Main Menu, press the [MENU] key at any time.

>FILES	· QUEUE	· TESTS
· COMMANDS	· OPTIONS	

Figure 2.2 Main Menu (P1500)

>FILE	TESTS	OPTIONS
-------	-------	---------

Figure 2.3 Main Menu (P1000 and P100)

From the File(s) Menu you can edit, load, copy (P1500 only), or delete a file. In the Options Menu, you can set up or change your instrument's configuration. The Tests Menu provides access to performance-related diagnostic tests and maintenance-related menus. Two menus are present only in the P1500: Commands and Queue. The Commands Menu lets you hold, continue, or reset the pump. From the Queue Menu you can edit or change the order and number of files in the queue. Refer to Chapters 3 and 4, and for more information on any of the instrument menus.

Status Screen

The status screen automatically appears whenever you turn on the instrument or press the [STATUS] key. The P1500's Status Screen (Figure 2.4) displays the pump's state (or time), flow, selected solvent, and the pressure. The P1000 and P100 Status Screens (Figure 2.5) show the pump's state (or purge time), flow, and pressure. Below either Status Screen is the Status Menu, described next.

Status	Flow	Solv	PSI
READY	1.00	A	6000▼

Figure 2.4 The Status Screen (P1500)

Status	Flow	PSI
READY	1.00	1250 ▼

Figure 2.5 The Status Screen (P1000 and P100)

Status Menu

Just below the Status Screen is the Status Menu. To access the Status Menu, press the down-arrow key from the Status Screen. The Status Menu lets you review and edit run parameters during a run (Chapter 3).

MESSAGES

Three kinds of messages can appear on the pump's display: user messages, confirmation messages, and error messages.

User messages

User messages (Figure 2.6) tell you about an existing instrument condition or ask for further action. Some of these will only appear on the display for three seconds. An example of a message requiring further action is shown in Figure 2.6.

To install or remove liquid ends, press ENTER

Figure 2.6 An example of a user message

Confirmation messages

Confirmation messages (Figure 2.7) indicated on the display by asterisks appear for one second after an operation has been carried out successfully.

* * File Loaded * *

Figure 2.7 An example of a confirmation message

Error messages

Error messages (Figure 2.8), indicated on the display by exclamation points, are displayed whenever an undesirable condition exists that prevents the instrument from carrying out an operation. Error messages remain on the display until you press a key.

!! MAX PRESSURE !! EXCEEDED

Figure 2.8 An example of an error message

Practice Examples

This section will take you step-by-step through four operations:

1. Setting a display option.
2. Creating a file.
3. Purging a solvent line.
4. Running a flow stability test.

These examples assume that the pump is properly installed using the procedures in Chapter 1 and that the bypass valve's outlet is routed to a solvent waste container.

SETTING A DISPLAY OPTION (CHANGING PRESSURE UNITS)

The pump's default display can be changed to suit your own needs. For example, you can use the steps below to change the pressure units from the default in PSI to megapascals.

1. Press [MENU]. Press [→] to move the cursor to /Options/, then press [ENTER] to access the Options Menu.
2. Press the down-arrow key [↓] until you see the /More/ selection. With the cursor next to /More/, press [ENTER] to access the More Menu.
3. The display now looks similar to Figure 2.9:

Pressure Units	PSI■
Purge Mode	Flow

Figure 2.9 The More Menu

4. The cursor should be to the right of the value in the Pressure Units field (PSI). Press [+] until the field shows MPa.
You have just changed the display so that all pressures will be shown in megapascals. If you prefer other units, press [+] until you see another preset choice that suits you.
5. You'll also need to move the cursor between fields to set method parameters. For example, move the cursor down to the Purge Mode field. Use [+] to see the Pressure selection (pressure). Press [+] once more, to change the Purge Mode selection back to Flow.
6. You may exit the More Menu in several ways. This time, press [STATUS] to exit the menu.
7. Press [v] to display the Status Menu, which shows the run file.

EDITING A FILE

Editing a simple file is a good way to become familiar with entering values and moving the cursor between menus.

1. Press [MENU].
2. With the caret (>) next to /FILE(S)/, press [ENTER] to access the File(s) Menu.
3. The cursor should be on the /Edit/ selection. Press [ENTER] to access the Edit Menu.
4. The cursor is either in the File field (P1500), or in the Flow Rate field (P1000).
5. If you have a P1000 (Figure 2.10), use the [+] key to enter a flow rate of 1.50 mL/min in the Flow Rate field.

Flow Rate	1.50
Maximum Pressure	6000

Minimum Pressure	0

Figure 2.10 The Edit Menu (P1000 and P100)

If you have a P1500 (Figure 2.11):

- a) Use the [+] key to select a file number. (Ignore the File Name field for now.)
- b) Press [v] until you reach /Solvent Program/. Press [ENTER] to access the Solvent Program Menu.
- c) The cursor should be in the Solv field. Press [+] to select solvent B, then press [>] to move the cursor into the Flow field. Enter a flow of 1.50, again using the [+] and [-] keys.

Time	Solv	Flow
0.0	B	1.50

Figure 2.11 The Edit Menu (P1500)

6. Press [^] until you return to the File(s) Menu.

PURGING A SOLVENT LINE

You may already be familiar with the purge operation from Appendix A. If so, skip this example and go on to *Running a Flow Stability Test*.

In this example, you will purge a solvent line.

1. Open the bypass valve on the pump. Make sure that the bypass valve outlet is routed to a solvent waste container.
2. Press [STATUS]. The Status Screen should show that the pump is stopped (Figure 2.12 and Figure 2.13.)

Status	Flow	MPa
STOP	1.50	1

Flow	MaxP	MinP
1.50	21	0

Figure 2.12 Status Screen and Status Menu (P1000 and P100)

Status	Flow	Solv	MPa
STOP	1.50	B	1

File 1:			
Time	Solv	Flow	
0.0	B	1.50	
Maximum Pressure			21
Minimum Pressure			0
Equilibration Time			0.0
(The pressure units displayed may be different depending on your selection in the example above.)			

Figure 2.13 The Status Screen and Status Menu (P1500)

3. Leave the Status Screen and go to the Purge Menu by pressing [PURGE] (the blank key).
4. The cursor should be in the Purge field. Note that the screen displays the flow rate in mL/min and the purge time in min. See Figure 2.14 for the P1000 and P100 and Figure 2.15 for the P1500.

Purge	Flow	Time
	1.50	0.0

Figure 2.14 The Purge Menu (P1000 and P100)

Purge	Flow	Time
1 B	1.50	0.0

Figure 2.15 The Purge Menu (P1500)

- If you have a P1500 pump, use [+] to select solvent B in the Purge field. If you have a P1000 pump continue with step 6 below.

Now you will actually begin the purge cycle.

- Move the cursor to the Time field either by pressing [ENTER] or [>]. Enter 2.00 minutes in the Time field, then press [ENTER].

The pump motor will start. The pump will purge solvent for two minutes at the flow rate shown in the Flow field. You can stop the purge operation at any time by pressing [STOP]. After the purge is complete, the pump will automatically initialize the run file.

Remember to close the bypass valve immediately following the purge so that solvent flow returns to the LC.

RUNNING A FLOW STABILITY TEST

The flow stability test is a common test of the pump's performance. The pump must be running, or be in a READY or QREADY (P1500 only), or EQUIL state for this test to be initiated, and the flow rate must be greater than 0 mL/min. If you need to change the flow rate, edit the flow setting from the Status Menu, then proceed with the steps below.



NOTE: The Flow Stability test can be completed only when the pump is in a READY state although it may be initiated while the pump is in any of the states mentioned above.

- When the Status Screen shows READY, press [MENU] and select /TESTS/.
- Select /Diagnostics/ from the Tests Menu.
- The cursor should be on /Flow Stability/. Press [ENTER].

After a short time, the flow stability rating followed by a numerical value will appear. STABLE flow corresponds to a reading between 0 and 25, ACCEPTABLE is between 26 and 90, and UNSTABLE is a value greater than 90.



NOTE: The Flow Stability test may show unstable flow during solvent switching in the P1500, or during column equilibration.

3

Basic Operations

Introduction

This chapter contains a general theory of LC pump operations, recommended laboratory practices, and how to perform routine operations on your P1500, P1000, or P100 SpectraSYSTEM or SpectraSERIES pump. Specifically included are procedures for editing, loading and running a file, and reviewing the pump operations status.

Before beginning this chapter, be sure that you have properly installed the pump using the procedures in Chapter 1 and that you are familiar with the pump keypad and menus as discussed in Chapter 2.

Theory of Operation

The pump is typically the second of five components in an LC system (degasser is the first). A pump delivers a steady flow of one or more solvents to a sample-injection instrument (generally an autosampler). This solvent flow continues through the column and on to a detector. From the detector, a signal is passed to an integrator, a recorder, or another kind of data system capable of collecting the data and allowing the data of the injected sample to be analyzed. The P1500, P1000, P100 isocratic pumps precisely and accurately deliver a mobile phase to the LC. The P1500 pump has the added capability of allowing the user to choose between two different mobile phases, and switch before, during, or after a run.

Solvent flow rate is specified in the run file. The solvent travels to the pump head where a piston meters the flow of the mixture to an outlet tube. The pump's outlet tubing then connects the solvent stream to an automatic or manual injector.

SpectraSYSTEM and SpectraSERIES Isocratic Pumps

The SpectraSYSTEM and SpectraSERIES pumps have been designed for ease of use and unsurpassed performance. Any one of them can be used as a stand-alone pump or as a module in a totally automated LC system.

AVAILABLE MODELS

The P1500 pump is a two-solvent pump suited for isocratic applications and solvent switching applications. It contains a total of forty time lines in as many as four method files (forty lines per file maximum) 40 lines per file or 240 time lines.

The P1000 and P100 pumps are single-solvent isocratic pumps. Rugged, reliable, and easy to use, they feature a Shutdown option and Maintenance Log. The P1000 can be connected to other SpectraSYSTEM modules through RS-232 communication; the P100 functions as a stand-alone module.

All SpectraSYSTEM pumps are engineered for reliability and ease of maintenance. Easy maintenance helps to ensure that your chromatography results are accurate and remain accurate. The built-in, patented Maintenance Log (Chapter 5) allows you to follow the life span and use of seals, pistons, and check valves. If service is ever required, the resident diagnostics and modular design of the pump will keep downtime to a minimum. The simplicity and durability of the pump means that a minimum of spare parts needs to be kept on hand.

Table 3.1 File Characteristics for Isocratic Pumps

File Characteristics	P1500	P1000	P100
Time Lines/File	40	0	0
Total Number Files	4 + Shutdown	1	1
Total Time Lines	240	N/A (flow rate only)	N/A (flow rate only)

OPTIONS

Narrow-bore

LC refers to the use of narrow-ID, 2.0-3.0 mm columns for LC separations. To optimize LC instruments for narrow-bore LC, standard LC hardware must be modified to reduce extra-column volume and gradient delay. Specific hardware modifications include minimizing the pump's dead volume, the detector flowcell's volume, and the volume contained in any interconnecting tubing and fittings. The lower system volume of narrow-bore LC increases sample concentration, which results in greatly improved sensitivity. Decreased solvent consumption reduces operating costs as compared to standard (4.0-4.6 mm ID) LC separation techniques.



NOTE: For narrow-bore applications we recommend you use a 20 μ L sample loop in Thermo Electron autosamplers.

Hardware Modifications

Pumps: For the SpectraSYSTEM gradient pumps, the following hardware changes have been made to create a compatible pump for narrow-bore applications.

- The solvent inlet line (from the gradient valve to the inlet check valve) is changed from 0.060-inch to 0.030-inch ID tubing and shortened from 12 cm to 10 cm.
- All interconnecting tubing has been changed from 0.020-inch ID to 0.010-inch ID.
- The outlet liquid end is changed from the standard to the low-volume design.

Autosamplers: For the SpectraSYSTEM narrow-bore autosamplers the pump-to-autosampler tubing (~ 6 inches long) and pre-heat tubing (~ 24 inches long) has been changed from 0.020-inch ID to 0.007-inch ID.

Operational Considerations

Injection Mode: We recommend that you consider the following in setting up your methods and LC instrumentation. Due to the manner in which the pump firmware stores certain values and references the hardware, the minimum operating pressure for these pumps is 200 psi.

We recommend that you use the PushLoop® mode for most narrow-bore applications; however, depending on your sample volume, other injection modes may be *more* beneficial in some cases (see below).

The following algorithms define the amount of sample needed for your injection volume:

PushLoop (Injection Volume + 15 µL)

Pull Loop (Injection Volume + 1.1 µL)

Full Loop (Injection Volume x 1.33) + 70 µL

In PushLo mode, the smallest settable sample volume is 0.1 µL. Allowed volume increments are also 0.1 µL. You should not inject more than 10 µL without changing the standard 20 µL loop. The autosampler is supplied with a 20 µL loop.

Reducing Extra Column Volume: Minimizing extra column volume maximizes analytical efficiency. Band-broadening can occur in several ways. With narrow-bore columns, it is vital that good plumbing connections are made. Otherwise, a dead volume created by a bad fitting can result in much lower than expected efficiency and peak resolution. Use zero dead volume (ZDV) fittings only with the proper nuts and ferrules. Cut and debur tubing with the proper tools. For polymer tubing (*e.g.* PEEK), use a "guillotine" cutter to ensure straight, right-angle cuts.

The flowcell volume is probably the single largest contributor to extra column volume in a narrow-bore system. Use the smallest internal volume cell you can find, subject to path length requirements.

Inert/Biocompatible

An inert/biocompatible configuration is available for all SpectraSYSTEM and SpectraSERIES pumps for metal-sensitive biomolecules or corrosive mobile phases. In this configuration, all wetted surfaces are PEEK™, or Teflon®.

Instrument Startup

Be sure you have installed the pump according to Chapter 1 and have completed the Startup Checklist.

When you turn on the pump, the Status display appears. This allows you to check the instrument settings before entering your parameters. As described in Chapter 2, it is possible to edit a file under the Status Menu. If you have turned on the pump before, and have used this editing capability, the Status Menu will contain the parameters last saved.

At powerup, there are no messages to alert you that a file is being loaded, but you can check the file number and name by pressing the [STATUS] key. Then use the down-arrow key to scroll to the file listing. (Both the [STATUS] key and the creation of files are discussed later in this chapter.)

Some Routine Operations

Ordinarily, you perform these operations with your pump every day:

- Edit a file (or create a new file) and load a file to run
- Run your samples
- Purge the solvent lines
- Check the pump's status
- Monitor pump performance
- Shut down the pump at the end of the day

The rest of this chapter is devoted to explaining these basic operations. If you need to, refer to the keypad “rules” in Chapter 2. You may also want to refer to the basic menu structure presented on the quick reference cards in the front pocket of your manual.

The File(s) Menu

In this section we describe how to set up the files that control solvents, pressures, flow rates, and run times. Each of the file operations accessed from the File(s) Menu is briefly defined, then described in detail.

To access the File(s) Menu, press [MENU] and select /FILES/ in the P1500 or /FILE/ in the P1000 or P100. The File(s) Menu for the P1500 is shown in Figure 3.1 and for the P1000 and P100 in Figure 3.2.

>Edit	·Load
·Copy	·Delete

Figure 3.1 The Files Menu (P1500)

>Edit	·Load
·Delete	

Figure 3.2 The File Menu (P1000 and P100)

Edit

Select /Edit/ if you want to change the parameters in an existing file, or create a new file. In the P1500, select the file by file number or letter (file S is the Shutdown file).



NOTE: The P100 has only a single method and a shutdown file.

Load

Select /Load/ to load the file you want the pump to use when in operation. In the P1500, make a file selection by file number. The loaded file is referred to as the run file.



NOTE: In the P100, press /Load/ to load the run file.

Copy (P1500 only)

Select /Copy/ to copy the contents of one file into another. Select both files by file number.



NOTE: In the P100 press load to load the run file.

Delete (P1500 only)

Select /Delete/ to delete the contents of a file and return all file parameters to their default values. In the P1500, select the file-by-file number. An information message allows you to cancel the delete operation before the file is deleted. Once deleted, the file cannot be retrieved.

EDITING A FILE

File editing in the P1000, P100, and P1500 are described separately below.

P1000 and P100

The P1000 and P100 contain only one file and its Edit Menu (Figure 3.3) consists of three fields.

Flow Rate	1.00
Maximum Pressure	6000

Minimum Pressure	0

Figure 3.3 The Edit Menu

Flow Rate: Enter a flow rate in mL/min. The maximum flow rate is determined by the liquid ends and head type. The head type is preset in the Maintenance Log Head Type field by Thermo Electron. The flow range of your liquid ends was preset by Thermo Electron.



NOTE: If you change the liquid ends, refer to the Maintenance Log description in Chapter 5.

Maximum, Minimum Pressures: Change the pressure levels as desired. The maximum value is 6000 psi, the minimum is 0 psi. (The allowed values depend on the pressure units.) The maximum pressure value must be greater than the minimum pressure. The pump will not allow you to set maximum and minimum pressures to values that are inconsistent. If you are unable to edit one value, try to edit the maximum valve first.



NOTE: Select pressure units (psi, bar, or MPa) from the Main Menu. Press /Menu /OPTIONS/, /More/ as described in Chapter 4.

Creating the Run File - A P1000 Example

Enter run parameters in the P1000 by first selecting /FILE/, /Edit/. The Edit Menu is shown in Figure 3.4.

Flow Rate	2.50
Maximum Pressure	4000

Minimum Pressure	0

Figure 3.4 Example P1000 Edit Menu

Simply enter a flow rate, and the maximum and minimum operating pressures.



NOTE: Parameters are also easily changed from the Status Menu. Press [STATUS], then [v] to access active fields.

P1500

A P1500's file consists of four parts: File Name, Solvent Program, Options, and Timed Events. Selecting /Edit/ gives you access to these areas (Figure 3.5).

Edit File	1
File Name	1

>Solvent Program	
·Options	
·Timed Events	

Figure 3.5 The Edit Menu (P1500)

To use the Edit Menu, select the file number in the Edit File field using the [+] / [-] keys. The P1500 pump has file numbers 1 through 4, and S. File S is described on page 43.

If a particular file cannot be accessed, the File Protect feature for that file has been turned on, preventing changes or deletions. When the File Protect feature has been turned on, a message appears on the display, indicating that the file cannot be edited. (File Protection is discussed in OPTIONS, More Menu in Chapter 4.)

File Name

You can enter or change the File Name using the [+] / [-] keys. The File Name field is eight characters long. Any name you enter is automatically remembered by the pump, so you do not need to formally "save" the name. All of the parameters discussed below are automatically remembered by the pump when you edit a file from the Files Menu.



NOTE: When changing the parameters of a run file from the Status Menu, you must select /Save File/ in order for the pump to remember your changes for future runs. However, the pump will use your changes until the next time the file is initialized (either by pressing [RUN] if the pump is stopped, or by selecting /FILES/, /Load/), regardless of whether the file has been saved. Editing a run file from the Status Menu is discussed in more detail later.

The Solvent Program Menu

The Solvent Program Menu contains time lines used to switch between two solvents. Each time line consists of a time (in minutes), a solvent, and a flow rate (in mL/min). When /Solvent Program/ is selected, the display shows (Figure 3.6).

Time	Solv	Flow
0.0	A	1.00

Figure 3.6 A P1500 solvent program

GENERAL RULES FOR ENTERING TIME LINES

The solvent and flow for the zero (0.0) time line are always editable. The Time field 0.0 itself is not editable; it remains as time zero. To add new times you must create new time lines.

To create a new time line, use the down-arrow key to go to a blank line, or press [ENTER] until a blank line appears, then press the [+] key. The new line, automatically incremented one minute past the previous line, will be displayed. The cursor will appear in the Time field of the new line. The Time field in any new line is editable.



HINT: Don't add all your time lines to the file at once. Enter flow in the first time line, then add a new time line. The solvent selected and flow rate will be copied to the new line automatically. In fact, a new line is always identical to the one just before it, with the exception of the Time field as discussed earlier.

You can enter times in any order you choose. The pump will automatically rearrange the time lines on the display so that they are in chronological order as soon as you move the cursor off the Time field.

The P1500 has four user-definable files and the Shutdown File. It allows 40 time lines per file. Figure 3.7 shows an example of a file entered into the P1500.

Time	Solv	Flow
0.0	A	1.00

1.0	B	1.00
2.0	A	1.00
3.0	A	1.00

Figure 3.7 Example P1500 solvent program

In this example, the pump delivers solvent A until 1.0 minute into the run. After one minute the pump switches solvents so that solvent B is pumped until 2.0 minutes into the run. Then the pump resumes pumping solvent A until the end of the run at 3.0 minutes.



NOTE: Parameters are also easily changed from the Status Menu. Press [STATUS], then [v] to access active fields.

OPTIONS MENU (P1500, P1000, and P100)

The Options Menu consists of maximum and minimum pressure levels, and an equilibration time. You are not required to set any values in this menu, although you should always set a maximum pressure level, since the pump will warn you whenever operating pressures exceed this level.

You can access the Options Menu from /FILES/, /Edit/ (Figure 3.8) or by pressing [ENTER] or [v] on the blank line at the bottom of the Solvent Program, then selecting /Options/.

Maximum Pressure	3000
Minimum Pressure	0

Equilibration Time	0.0

Figure 3.8 The Files, Options Menu

Maximum, Minimum Pressures

Change the pressure levels as desired. The maximum value is 6000 psi, the minimum is 0 psi. (The allowed values depend on the pressure units, selected in /OPTIONS/, /More/, Pressure Units.) The maximum pressure value must be greater than the minimum pressure. The pump will not allow you to set maximum and minimum pressures to values that are inconsistent. If you are unable to edit one value, try to edit the maximum value first.



NOTE: Pressure units (psi, bar, or MPa) are selected from the Main Menu, /OPTIONS/, /More/, described in Chapter 4.

During operation, the pump continuously monitors the actual operating pressure and displays this on the Status Screen. If the actual pressure ever exceeds the maximum pressure level, or falls below the minimum pressure level set here, an error message will alert you to this circumstance. For more information about using this error feature, refer to Chapter 4, Options, Error Recovery.

If desired, enter a value for the equilibration time. The equilibration time is the time that the pump will maintain the conditions (solvent and flow) specified on the first line of a run file (the zero time line), before showing READY on the Status Screen.

TIMED EVENTS MENU

You can access the Timed Events Menu from /FILES/, /Edit/, or by pressing [ENTER] or [v] on the bottom line of the Options Menu, then selecting /Timed Events/. The Timed Events Menu is shown in Figure 3.9.

Time	Event
0.00	Off

Figure 3.9 The Timed Events Menu

For P1500 only, a timed events output is available at the external events port. This output can be used to control an external device such as a column switching valve. The output can be turned on or off up to six times per run.

The time on the first line of the menu remains 0.0. Additional timed events are added much like time lines in the Solvent Program. Use the down-arrow key to reach a blank line, then press [+]. As many as five additional lines can be added. The Time field in any added line is editable. Enter times and turn the output Off or On in any of the six Event fields using the [+] / [-] keys. Figure 3.10 shows a Timed Events Example.

Time	Event
0.00	Off

6.50	On
9.00	Off

Figure 3.10 Timed events example

In this example, a timed event output (signal) would be sent (turn on) at 6.5 minutes into the pump's run and become inactive (turn off) two and a half minutes later, at 9.00 minutes.

To delete a line, move the cursor to the time field, then press and hold [-]. The time field will eventually become blank, and the line will disappear. If the time has more than one non-zero digit (*e.g.* 6.50), then decrement each digit, starting with the left-most digit. Release the [-] key after each field becomes blank and decrement the next digit.

SHUTDOWN FILE

The Shutdown file is file number S in the P1500. In the P1000 and P100, the Shutdown file in the P1000 is accessed from /OPTIONS/, /Shutdown/.

Making use of the Shutdown file assists you with the proper maintenance of the pump. Since your pump and column should never be allowed to sit idle with salts or corrosive materials in them (including water), the Shutdown file lets you automatically flush the pump and the column at the completion of a series of samples.

Whenever the pump detects that it has been in a READY state, without a run being initiated for a specified period of time, it automatically loads, initializes, and runs the Shutdown file when time from Ready has been reached.



NOTE: The pump's clock is reset any time the [STOP] key is pressed, or anytime the /Reset/ command (P1500) is issued.

Some instances when you might want to use a shutdown file are:

- to keep solvent at a very low flow rate flowing through the LC
- to clean the column and keep the pump running
- to clean the column, then stop solvent flow through the LC



NOTE: If the pump will be operated unattended for an extended period of time, ensure that the solvent reservoir and waste containers have sufficient capacity.

If you use an autosampler, specify the time interval to be longer than the cycle time on the autosampler (*e.g.*, [1.5 x cycle time], or [cycle time + 20 minutes]). If you perform manual injections, set the time interval to the maximum time likely between injections. Depending on your own circumstances, you may wish to turn the Time from Ready to "Off."

The P1000 and P100 Shutdown Menu is shown in Figure 3.11. The Flow field contains the flow rate parameter. The Time field contains 11 preset choices: Off, and ten time values, ranging from 5 to 480 minutes. The value selected in the Time field is the length of time

the pump will remain in a READY state before it automatically loads and runs a shutdown file. So, for example, if you select 60 minutes, then whenever the pump senses that it has been READY for 60 minutes without a run being started, it will load and run the Shutdown parameters.

Flow	Time
1.00	20

Figure 3.11 The Shutdown Menu (File), accessed from /OPTIONS/, /Shutdown/ (P1000 and P100)

P1500 Shutdown File

The P1500's Shutdown file's Solvent Program, Options, and Timed Events Menus are exactly the same as those for other files with one exception: in the last line of the Options Menu, the display shows a Time from Ready field instead of the Equilibration Time field (Figure 3.12).

Minimum Pressure	0
Time from Ready	Off

Figure 3.12 Last lines of the Options Menu of the P1500's Shutdown file

The Shutdown file will be automatically loaded and run if the current run file has not been started, either manually or remotely, in the time specified in the Time from Ready field. There are ten preset times (in minutes) that can be selected in this field: 5, 10, 20, 30, 45, 60, 90, 120, 240, or 480. The Shutdown feature can be turned off completely by selecting "Off." The Time from Ready timer starts as soon as the Status Screen shows READY.

When the Shutdown File Loads Automatically

If the Shutdown file is loaded automatically, the pump will do one of the following when it reaches the last time line of the Shutdown file:

- a. (P1500, P1000, and P100) If the flow rate is greater than zero (> 0.0) the pump will maintain (Hold) the last time line's flow rate indefinitely.
- b. (P1500) If the flow rate is zero (= 0.0) then the pump stops, and STOP is shown on the Status Screen. In addition, the pump remembers the run file that had been used just before the Shutdown file was automatically invoked, and restores that file to the run file position. (If you setup the pump with the ISM100, you can program the pump's behavior to be different from this.)

If the Shutdown file is loaded manually (P1500 only, /FILES/, /Load/), it begins to run immediately. The previously used file is restored to the run file position when the Shutdown file stops.

LOADING A FILE

When using the P1500, when you select /Load/ the display shown in Figure 3.13 appears.



```
>Load File 1: (filename)
```

Figure 3.13 Load display (P1500)

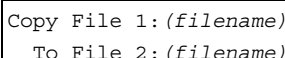
Select a file by number (P1500 only), then press [ENTER]. For the P1000 or P100, select /LOAD/ and the file is loaded. A message will confirm that the file was loaded. A loaded file is referred to as the run file.

As soon as a file is loaded, the pump will initialize the file, *i.e.*, bring the pump to the conditions specified on the zero (0.0) time line of the file. The Status Screen shows INIT. For the P1500, this is until these conditions are achieved. If an equilibration has been specified, the pump will then show EQUIL until the equilibration time has been reached.

After initialization and equilibration, the Status Screen then shows that the pump is READY. The pump's clock will not start unless a run is triggered either manually by pressing [RUN] or from a properly connected (hardwired) autosampler.

COPYING A FILE (P1500 ONLY)

When you select /Copy/ the display shows (Figure 3.14):



```
Copy File 1: (filename)  
To File 2: (filename)
```

Figure 3.14 Copy display

Select both files by number. Press [ENTER] after both files are specified only if you are sure you want to copy the parameters from the top file into the other file. The Copy command overwrites the selected file. Once overwritten, previous values cannot be retrieved. If you do not want to copy a file, leave the display by pressing [MENU] or [STATUS], or the up-arrow key. Press [ENTER] to proceed with the copy operation. A message confirms its completion.

If you try to copy to a protected file, a message will appear indicating that the file is protected. You will then be returned to the Copy display.

DELETING A FILE

For the P1500, when you select /DELETE/ the display shows (Figure 3.15): For the P1000 or P100, selecting /DELETE/ will delete the file.



Figure 3.15 P1500 Delete display

Select a file by number (P1500 only), then press [ENTER]. A message is displayed, asking you to confirm the selection. Press [ENTER] only if you are sure you want to delete the file. Once deleted, a file cannot be retrieved. If you do not want to delete the file, leave the display by pressing [MENU] or [STATUS], or the up-arrow key. A confirmation message concludes a successful file deletion.

When you delete a file you are actually returning all parameters in the file to their default values.

If you try to delete a protected file (P1500 only), a message will appear indicating that the file is protected. You will then be returned to the Delete display.

Purging Solvent Lines

If none of the solvent lines has solvent in it, refer to *Priming the Pump* in Chapter 1.

Air will slowly diffuse through the thin-wall Teflon inlet tubing, and into the solvent. If the pump flow has been turned off or if any of the solvent lines from the solvent reservoirs to the switching valve (P1500) have not been used in the past several hours, those lines should be purged with degassed solvent before use.

The purge operation can be activated when the pump is in any state.



NOTE: *Open the bypass valve prior to purging, or else ensure that your chromatographic column can withstand the purge parameters you set before performing any purge.*

THE PURGE MENU

Pressing the [PURGE] key displays the Purge Menu to the display.



NOTE: DO NOT move the cursor out of the Time field using the [ENTER] key unless your LC is ready to start a purge.

Purge	Flow	Time
	1.00	0.0

Figure 3.16 The Purge Menu (P1000 and P100)

Purge	Flow	Time
A	1.00	0.0

Figure 3.17 The Purge Menu (P1500)

Purging can be accomplished in any of three purge modes: Flow, Pressure, or Both. Table 3.2 describes purging across the three modes.

Table 3.2 Purging mechanisms for the three purge modes

<u>Modes</u>	<u>Purging requirements</u>
Flow Mode	Regulated by the flow rate from the pump
Pressure Mode	Accomplished at a specific pressure
Both Mode	Uses both flow and pressure parameters

Internal limits are designed to protect your LC system: in flow mode, the pump will accept rates of 0.01 to 10.0 mL/min. The maximum pressure the pump allows in flow mode is the maximum pressure value from the current run file; in pressure mode, the maximum flow the pump will reach in attaining the set pressure is 6 mL/min.



NOTE: Purging in Pressure or Both mode with the bypass valve open may not allow sufficient pressure to be generated in the system. The pump will operate at maximum flow, but the target purge pressure may not be achieved. Ensure that your analytical column can withstand the purge pressure (or use a flow restrictor or old column), and do not open the bypass valve.

The purge mode is changed from /OPTIONS/, /More/, Purge Mode.

The top line of the Purge Menu will show either Flow or pressure units (PSI, BAR, MPa), depending on the purge mode you select.

Purge (field)

There are two choices available in the Purge field for the P1500, A, and B.

Flow or pressure (PSI, BAR, or MPa)

The flow rate is taken from the last time line of the run file. Use this field to select a flow rate. If the purge mode is pressure, the pressure is automatically set to one-half (50%) of the maximum pressure level set in the run file.



NOTE: To change the purge mode you must go to /OPTIONS/, /More/, Purge Mode. Refer to Chapter 4 for complete information.

Time

The Time field is used to set the length of time you want the pump to purge. If the field remains 0.0, purging, once started, will continue until you press the [STOP] key.



NOTE: When you check the purge operation from the Status Screen, the time remaining to complete the purge is shown below the word Status.

Starting a Purge

To initiate a purge cycle, move the cursor out of the Time field by using the [ENTER] key.

The pump will begin to purge solvent. If the time stays set to 0.0, purging will continue until you press [STOP], or a file is initialized. If a time is entered, the pump will purge until the time set. After completing a purge, the pump automatically initializes the run file.

When running in a timed purge mode, the Status Screen will indicate the time *remaining* to purge (*i.e.*, counts backwards toward 0.0). If the [PURGE] key is pressed once more, the Purge Menu is again displayed and the time countdown continues, uninterrupted, unless the cursor is moved out of the Time field by pressing [ENTER], at which point the timer will be reset and purging will restart.

The pump will retain the selections made in the PURGE display as long as the power to the pump is on.

Stopping a Purge

There are three ways to stop a purge cycle:

- Press the [STOP] key
- Load (initialize) a file by selecting a file using /FILE(S)/, /Load/
- Allow the pump to complete the purge (if a time has been specified), at which point the pump will automatically initialize the last run file.

Starting a Run

To perform a run:

- Purge the solvent lines if necessary
- Load a file or press [RUN] to establish a READY state,
- Inject the sample, and
- Press [RUN].
- If you are performing a manual injection, fill the injection loop, check that the Status Screen shows READY, inject the sample, and press [RUN] in succession.
- If an autosampler is hardwired to the pump, simply initiate the autosampler run sequence.



NOTE: Generally, when operated manually, if the pump is stopped (i.e., the Status Screen shows STOP), the run file can be initialized by pressing [RUN], and then started by pressing [RUN] again when the Status Screen shows READY.

ESTABLISHING READY

The READY state means that the pump has reached the conditions specified on the first line of the solvent program and is ready to start a run.

Initializing a File

To achieve the READY state, initialize a run file, by any of the following methods:

- Load a file by selecting /FILE(S)/, /Load/, a file number, then pressing [ENTER]. This simultaneously loads the run file and initializes it (P1500).
- If the pump is stopped (Status Screen shows STOP), press [RUN]. This initializes the run file, without starting the run.
- For the P1500 only, if the pump is stopped or in run, reset the run file by selecting /COMMANDS/, /Reset/. This initializes the run file without starting the run.

Wait for the pump to reach zero time line conditions. If an equilibration time was specified in the file, the Status Screen will show EQUIL for this period of time.

PRESSING [RUN]

As soon as the pump shows READY, begin the run by pressing the [RUN] key. This starts the pump's clock.



NOTE: Even though the pump may be ready, your column and the rest of your LC system may not be! Take into account your own LC application and ensure that your column is at chemical equilibrium and that the other instruments in your system are ready before you proceed with any injection.

For the P1500 only, as soon as you press the [RUN] key, the pump begins to operate based on the time lines in the Solvent Program of the run file, and the Status Screen is displayed. The Status field shows the time into the run. Status is fully described on page 53.

STOPPING THE PUMP

There are a number of ways to stop the pump, depending on what you wish to do next. More information regarding the Commands Menu (P1500 only), referred to below, is found on page 51.

Using a Hold Command (P1500 only)

If you want to stop the pump's clock momentarily (but not stop solvent flow), and plan to resume the run where it was stopped, press [MENU], and select /COMMANDS/, /Hold/. To resume, select /COMMANDS/, /Continue/.

By Resetting the Pump's Clock (P1500 only)

If you want to restart the current run, press [MENU] and select /COMMANDS/, /Reset/. This stops the pump's clock and returns to the zero time line, automatically initializing the file. Restart the run by pressing [RUN] after the pump shows READY.

By Pressing [STOP]

If you want to completely stop the pump, press [STOP]. This aborts the run and stops solvent flow through the pump. If you want to resume with the same file, you must initialize the run file by pressing [RUN], waiting for the pump to show [READY], then pressing [RUN] again.

While the Pump is Running

There are several messages which can appear in the Status field. These are discussed in detail in the *Status* section below.

While the pump is running you may do several things without disturbing pump operation:

- Edit files (/FILE(S)/, /Edit/).
- Check *some* pump performance parameters.
- Edit the run file from the Status Menu. (This has an effect on the current run. See page 54 for more information.)

The Commands Menu (P1500 only)

The Commands Menu (P1500) is reached by pressing [MENU] and selecting /COMMANDS/.

When /COMMANDS/ is selected the display shows (Figure 3.18).



```
>Reset
·Hold
-----
·Repeat
```

Figure 3.18 The Commands Menu

REPEAT

The Repeat command initiates two different events, depending upon what the pump is doing when the command is issued:

- 1) If a queue is running, the /Repeat/ repeats the run currently in progress.
- 2) If a queue is not running, the /Repeat/ is identical to /Reset/.

RESET

Reset is used when the pump is in RUN and you want to abort the run without stopping the pump's flow. Reset reinitializes the file (*i.e.*, resets the timer to zero). The result is that the pump reestablishes the conditions of the zero time line, and returns the pump to a READY state. Pressing [RUN] restarts the run.

HOLD/CONTINUE

Hold is used to stop and hold the pump's clock. It causes the pump to maintain the operating conditions used at the moment the Hold command was issued, including flow rate. These conditions are maintained indefinitely unless:

- A Continue command is used from the Commands Menu, at which point the timer continues from the point at which it was held.
- The [STOP] key is pressed.
- The Reset command is selected.

Whenever a Hold command is issued, the word Continue will replace the word Hold in the Commands Menu.

To select any of the commands on the Commands Menu, move the cursor to the desired line, and press [ENTER] to issue the command. The display returns to the Status Screen.

Status

The Status Screen appears whenever the pump is powered on, a file is initialized, or the [STATUS] key is pressed. The Status Screen, consisting of two lines, shows the pump's current operating values. Below the Status Screen is the Status Menu, where you can view and, if necessary, edit the run file parameters.

STATUS MESSAGES

The P1500, P1000, P100 can show any of the following messages:

Table 3.3 Status Messages

(time)	The time into the run (or time remaining if a timed purge).
EQUIL (P1500)	The pump is equilibrating the LC by maintaining the conditions on the first line of the run file for the equilibration time specified in the file.
HOLD	/COMMANDS/, /Hold/ has been selected. The pump is maintaining the conditions that existed when the Hold command was issued, including the flow rate. To continue, select /COMMANDS/, /Continue/.
INIT	The pump is initializing a file.
Q (time) (P1500 only)	The file listed in Order 1 of the queue is running. The time into the current run is shown.
QEQUIL (P1500)	The pump is equilibrating the LC based on a file listed in the queue.
QINIT	The pump is initializing a file in the queue.
QREADY (P1500)	A queue has been loaded and the run specified in Order 1 can be started.
Q RUN (P1500)	Appears briefly when a queue is run.
QSTOP (P1500)	A run listed in the queue has been stopped.
READY	The pump has achieved the conditions on the first line of the run file, and the equilibration time has elapsed (if set). A run can be started. READY, shown in Status
RUN	Appears briefly when the pump begins a run.
STOP	All mobile-phase flow through the pump is stopped.
SYNC	This is a remote communications message that appears briefly whenever a run is started. At lower flow rates, it may be seen for longer periods of time.

STATUS EXAMPLES

Shown below are two examples of an entire Status Screen and Status Menu.

P1000 and P100

Status	Flow	PSI
READY	1.00	1250 ▼

Flow	MaxP	MinP
1.00	6000	0

Figure 3.19 Example Status Screen and Status Menu

The first and second lines of the display show the state, flow, and pressure.

P1500

Status	Flow	Solv	PSI
STOP	1.00	A	0▼

File 1:EXAMPLE			
Time	Solv	Flow	
0.0	A	1.00	
1.0	B	1.00	
2.0	A	1.00	
Maximum Pressure			6000
Minimum Pressure			0
Equilibration Time			0.0
>Save File			
(appears only if the run file is changed)			

Figure 3.20 Example P1500 Status Screen and Status Menu

The first and second lines of the P1500's Status Screen show the state, flow, selected solvent, and pressure.

EDITING A RUN FILE

The remaining lines, which comprise the Status Menu, show the parameters and options of the run file. If the run file and options do not appear, the Status Lock feature has been turned on. (Status Lock is described in Chapter 4, under the OPTIONS, More Menu.)

All time lines of the run file's solvent program may be edited while the pump is running, as may the maximum and minimum pressures,

and the equilibration time. Any changes take effect as soon as the cursor leaves each field. However, the changes are saved only when the /Save File/ command is selected from the Status Menu (below Equilibration Time, P1500 only).

If you change the parameters of a P1500's run file from the Status Menu, you must select /Save File/ in order for the pump to remember your changes. The pump will, however, use your changes until the next time the file is initialized either through a /FILE(S)/, /Load/, by means of a remote run command, or through the queue.



HINT: (P1500 only) Any time the parameters of the Run File are changed, the /Save File/ command will appear at the bottom of the Status Menu. Note that you cannot save changes using the /Save File/ command if file protection for that file has been turned "On."

Use the same methods described on page 40 and on page 41 to edit the parameters of a run file. In the P1500 new lines may be added to the run file. Timed events may only be edited through /FILES/, /Edit/, /Timed Events/, and will not take effect until the file is reloaded.

Monitoring Pump Performance

SpectraSYSTEM pumps can automatically monitor their own performance and warn you if a flow problem exists. These options (not to be confused with File Options), are described in detail in Chapter 4.

Certain flow conditions are monitored continuously. For example, if a time line with a zero flow rate has been encountered, the pump responds with the appropriate error message shown below. As mentioned earlier, you can select the pump's response to certain conditions.

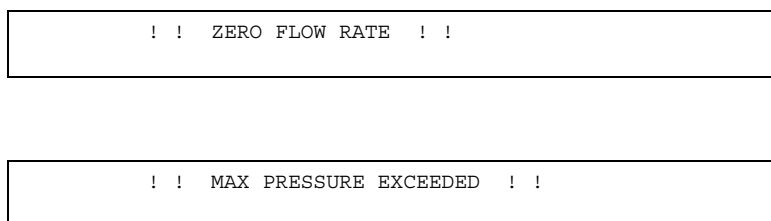


Figure 3.21 Example error messages resulting from flow problems

To choose a pump response, select /OPTIONS/, /Error Recovery/. (See Chapter 4, Options section.)

The pump can also initiate a Flow Stability Test. This test is run by selecting /TESTS/, /Diagnostics/, /Flow Stability/. The results are continuously displayed until another key is pressed. The results consist of two parts. The first is a summary of the performance evaluation (STABLE, ACCEPTABLE, or UNSTABLE) and the second is a number that indicates a position in each range. Further explanation of this test can be found in Chapter 4.

Shutting Down at the End of the Day

Some shut down suggestions when you conclude your work with the pump for the day:

- Do not leave buffers in the pump or in your LC; purge the pump (water is a good solvent) if it has just concluded a run using buffered solutions. (Don't leave water in your LC.)
- Leave the column full of a solvent recommended by the column manufacturer.
- Open the column bypass valve and purge using the same solvent as in the column so that the liquid ends are filled with that solvent.
- Make use of the Shutdown file. The pump will automatically maintain the conditions specified in the last or only line of the file. This is particularly useful if you prefer to have a small but continuous flow of solvent through your LC system while it is idle.

4

Advanced Operations

Introduction

This chapter focuses on three top-level menus: Options, used to set important, yet seldom changed features, Queue (P1500 only), used to build a list of files to run, and Tests, used to run the built-in diagnostics.

The Options Menu

The Options Menu (accessed from the Main Menu, not from /FILES/), contains seldom-changed features such as the pump's response to certain electrical and flow conditions it detects, user-selected display and operational preferences, and file protection.

```
· FILES                · QUEUE                · TESTS
· COMMANDS                >OPTIONS
```

Figure 4.1 The P1500's Main Menu with /OPTIONS/ selected

The P1500 Options Menu is shown in Figure 4.2; the P1000 and P100 Options Menu is shown in Figure 4.3.

```
>Error Recovery
·More
```

Figure 4.2 The Options Menu (P1500)

```
>Shutdown
·Error Recovery
-----
·More
```

Figure 4.3 The Options Menu (P1000 and P100)

The Error Recovery and More Menus are common to the P1500, P1000, and P100 pumps. The Shutdown feature is similar to the P1500's Shutdown file.

ERROR RECOVERY MENU

The pump continuously checks pressure so that problems can be indicated immediately on the display. The pump can also sense a power failure or power interruption. The Error Recovery Menu (Figure 4.4) is used to preset the pump's response to detecting error conditions in any of these three operating parameters.

AC Power Fail	Stop
@Maximum Pres	Stop

Figure 4.4 The Error Recovery Menu

Each field in the Error Recovery Menu can be set to one of three selections:

<u>Selection</u>	<u>Pump's Response</u>
Stop	The pump stops immediately if the condition is encountered.
Continue	The pump continues as if the condition had not occurred.
Shutdown	The pump immediately stops, then loads and runs the Shutdown file.

AC Power Fail

The pump may sense a power interruption at any time. Select Stop, Continue, or Shutdown in the AC Power Fail field to stop, continue, or shut down the pump as soon as power is restored.



NOTE: If the power switch is turned off while the motor is running, the pump considers this a power failure and will respond accordingly as soon as power is restored.

@Maximum Pres

In a file's Options Menu, you can change the maximum pressure level (the default is 6000 psi). If the pump's operating pressure ever exceeds this value, the pump will operate based on your selection in the @Maximum Pres field. Select Stop, Continue, or Shutdown to set the pump's response to sensing operation at maximum pressure.

MORE MENU

To access other options, select /More/ (Figure 4.5).

```
·Error Recovery  
>More
```

Figure 4.5 Selecting /More/

The More Menu (Figure 4.6) contains additional, miscellaneous, user preferences, such as the units the pressure is displayed in and how quickly field choices scroll when the [+] and [-] keys are pressed and held.

Pressure Units	PSI
Purge Mode	Flow

Cursor Speed	Medium
Status Lock	Off
Ready Output Active	Hi
File Name	Protect
1: (filename)	Off
2: (filename)	Off
3: (filename)	Off
4: (filename)	Off

(The P1000 and P100 More Menus do not contain the File Protect fields shown in the last 5 lines above)

Figure 4.6 The P1500's More Menu

Pressure Units

Select either PSI, BAR, or MPa as your preferred units. All menus and screens that show pressure units will reflect the selection.

Purge Mode

Select either Flow, Pressure, or Both in the Purge Mode field. Your selection is reflected on the Purge Menu and is used as the primary purge parameter. Select Flow if you wish to purge based on a flow rate, Pressure if you want to purge based on an operating pressure, or Both if you wish both flow and pressure parameters to govern purging.

Purging in Pressure or Both mode requires a certain amount of back pressure in the system. Ensure that your analytical column can withstand the purge pressure (or use a flow restrictor or old column), and do not open the bypass valve.



NOTE: You can select the P1000 and P100 purge modes from the Purge Menu.

Cursor Speed

Cursor Speed is used to change how quickly choices scroll on the display when the [+] and [-] keys are pressed and held, and how quickly a menu scrolls (up and down) when the arrow keys are pressed and held. Select Fast, Medium, or Slow.

Status Lock

Status Lock prevents a run file from being edited from the Status Menu. When Status Lock is On in the P1500, the Status Menu only shows the run file name (and number). The rest of the run file cannot be accessed.

The Status Screen is unaffected by Status Lock; it can always be viewed.



NOTE: (for P1500 users) Status Lock is different from File Protection (below). A protected file cannot be saved from the Status Menu using the /Save File/ command, although it can be viewed from the Status Menu. Also, you cannot edit a protected file from /FILE(S)/. Status Lock, on the other hand, prevents a run file from being seen (or edited) from the Status Menu. The file remains editable from /FILE(S)/.

Ready Output Active

The Ready output, located on the back of the pump, continuously sends an electrical signal to any device hardwired to it. Use the Ready Output Active field to choose whether the signal is either a 5V signal (Hi) or a 0V signal (Lo) whenever the pump is in a READY state. If the pump is not READY the other signal is output.

Whenever the pump's Ready Output is hardwired to a SpectraSYSTEM autosampler to coordinate injections, it should be set to provide "Hi" voltage in the READY state.

File Protection (P1500 only)

Each numbered file can be safeguarded against accidental or unauthorized changes by turning on the file protection feature. When File Protection for a specific file is turned On, that file cannot be edited, deleted, or copied to. Initially, all files are editable (file protection is Off.) Use the [+] or [-] key to select Off or On in the Protect field.

Shutdown Option (P1000 and P100 only)

The Shutdown Menu (Figure 4.7) contains the parameters the pump uses after it has been in a READY state, without a run being started, for a specified length of time after time from READY has been reached. More information about the Shutdown Menu is found in Chapter 3, page 43.

Flow	Time
1.00	20

Figure 4.7 The Shutdown Menu

The Queue Menu (P1500 only)

The Queue Menu (P1500 only) is used to edit, load or delete a chronological list of files the pump will run, and the number of times each file is run. By linking several files together by means of a queue you can match specific pump files with injections in your sequence. Any regular file (numbers 1 - 4) can be put into the queue. (You cannot queue the Shutdown file.)

You can create a queue with as many as ten lines. Access the Queue Menu by pressing [MENU] and selecting /QUEUE/ (Figure 4.8).



Figure 4.8 The Main Menu, showing /QUEUE/ selected

When you select /QUEUE/ the display shown in Figure 4.9 appears.



Figure 4.9 The Queue Menu

This section describes how the queue works, and how to edit, load, delete, and run a queue. It also explains how a running queue can be paused, stopped, or edited.

HOW THE QUEUE WORKS

The pump looks at the first line of the queue to determine which file to run. It then runs that file as many times as specified, with each run being initiated by a manual or remote RUN command.

To use the queue:

1. Edit the Queue.
2. Load the Queue.
3. Initiate the [RUN] manually each time a new injection/run needs to be started.



NOTE: Set the autosampler Cycle Time greater than the pump run time and data system post-run reporting time..

The pump will run based on the files listed in the queue. For the example queue shown in Figure 4.10, the pump would run File #4 ten times, then File #2 five times, and then File #1 twenty times, for a total of 35 runs. Note that the file number is not the same as the file's Order (chronological position) in the queue.

Order	File:Name	#Runs
1	4: (filename)	10

2	2: (filename)	5
3	1: (filename)	20

Figure 4.10 An Example Queue

Editing, loading, and deleting a queue are explained on the following pages.

EDITING THE QUEUE

To view, build, or change the queue, select /Edit/. A display similar to Figure 4.11 appears.

Order	File:Name	#Runs
1	#: (filename)	(1-999)

Figure 4.11 The Queue's Edit Menu

Order

The field is not editable. As you add more lines to the queue, this field automatically displays the numerical order of lines in the queue.

File Name

The File:Name field is used to select the name of each file to be run. Use the [+] / [-] keys to select one file for each line.

#Runs

The #Runs field is used to enter the number of times you want a particular file to be run before the next file (Order 2) is loaded.

Adding Lines to the Queue

Once the File:Name and #Runs fields for Order 1 are filled in, you can add an additional line to the queue by pressing the down-arrow key or [ENTER]. The cursor will move to the Order 2 line. For each line that you add, select a file name and enter a value for the number

of times you want the file to run. You may add as many as nine lines (for a total of 10 lines).

Order	File:Name	#Runs
1	#: (filename)	(1-999)

2	2:EXAMPLE	5

Figure 4.12 Adding lines to the queue



HINT: You may repeat a file name several times in the queue, if you wish.

Deleting Lines from the Queue

To delete lines from the queue, put the cursor in the File:Name field, and press [-] until the File:Name field is blank. The remaining entries will be re-sorted as soon as the cursor is moved off the line.

LOADING THE QUEUE

The Queue Menu's Load command simultaneously loads the queue into the pump and begins running the queue by initializing the file in Order 1. When /Load/ is selected, the display prompts you to confirm the operation (Figure 4.13). Press [ENTER] if you wish to proceed. (If you do not want to load the queue, exit the display by pressing [MENU], or [STATUS], or the up-arrow key.) A confirmation message will appear, completing the load operation.

>Load Queue

Figure 4.13 Loading the queue

DELETING THE QUEUE

The Queue Menu's `command` is used to erase the *entire* queue. When /Delete/ is selected, the display prompts you to confirm the operation (Figure 4.14). Press [ENTER] only if you wish to delete the *entire* queue. A confirmation message completes the operation.

If you do not want to delete the queue, press the up-arrow key, or [STATUS] or [MENU].

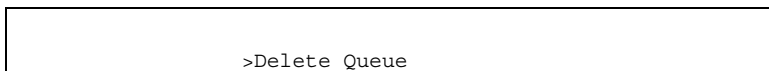


Figure 4.14 Deleting the queue

If you only want to delete certain *lines* of the queue, use the Edit Menu. Refer to the paragraph *Deleting Lines from the Queue* on page 65 for more information.

You can delete the queue at any time, regardless of whether or not it is running. If you delete a running queue, the current run is completed. The file that had been in Order 1 remains as the run file.



NOTE: Deleting a queue has no effect on the files themselves; it simply erases the list of files.

The contents of the queue is lost whenever the pump is switched off or a power failure occurs. The file that had been in Order 1 will be the run file when power is restored.

RUNNING A QUEUE

To run a queue, simply load it by selecting /QUEUE/, /Load/. When the pump's Status Screen shows QREADY, you can begin running the first file in the queue by pressing [RUN] or by having another LC instrument trigger the run. The pump will continue to run the file in Order 1 each time a new run is started, until it has been run the number of times specified in the #Runs field. The pump then loads the file designated in Order 2 and uses that file the number of times specified in that line, and so on, until the entire queue has been run.

CHECKING A QUEUE'S PROGRESS

You can track the progress of a running queue from the Queue Menu. To view the progress of a running queue:

1. Press [MENU].
2. Select /QUEUE/. Notice that when a Queue is loaded, the Queue Menu (Figure 4.15) changes. The /Load/ selection is replaced by /Pause/.

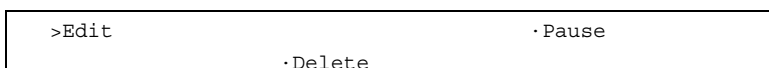


Figure 4.15 The Queue Menu when a queue is loaded (running)

3. Select /Edit/ to view the running queue. The display will look similar to Figure 4.15.

While the queue is running, you can see the #Runs field automatically decrease by one with each run (injection). When the last run is made for a file, the queue is automatically re-sorted. The information for Order 2 is moved up to Order 1, and the information for Order 3 is moved up to Order 2. This process continues until the queue becomes empty, is paused, or is deleted.

You can also see the progress of the current run in the queue from Status. When a queue is running, a Status Screen similar to Figure 4.16 will be displayed. Note that the Status Screen shows the letter Q, followed by the time into the run.

Status	Flow	Solv	PSI
Q 4.3	1.00	A	1250▼

File #: (filename)			
Time		Solv	Flow
0.0		A	2.00

Figure 4.16 A P1500 Status Screen when a queue is running

As always, the Status Menu shows the run file. The run file can be edited from the Status Menu (if Status Lock is Off), as normal.

EDITING A RUNNING QUEUE

You can edit a running queue in order to add, delete, or edit lines (File, #Runs). All lines of a running queue except the Order 1 line are editable. Refer to the procedure outlined in the Edit section on page 64 to edit the queue. If you need to make a change to the Order 1 line of a running queue, you must first pause the queue as described in *Using a Pause Command* on page 68. Note that the pump will always finish the current run before pausing.

EDITING A FILE IN THE QUEUE

You can edit any file in the queue that has not yet been run by selecting /FILES/, /Edit/. Since the pump only loads the file in Order 1 once, any changes made to the file specified in Order 1 do not take effect while the queue is running. If the same file is specified later in the queue, then the changes will be recognized, since the edited file is loaded at a later time. To edit the file shown in Order 1, you can either edit the run file from the Status Menu, or pause the queue (see page 68) then edit the file. If you pause the queue (and the #Runs for Order 1 is greater than 1), the edited file will be loaded as soon as the queue is re-loaded.

LOADING OTHER FILES

When a queue is running, you may not load any other file from the Files Menu without first pausing or deleting the queue. If you try to load a file while a queue is running, the information message shown in Figure 4.17 appears. You are then returned to the Files Menu. As described on page 68 you can load another file *into the pump* by first pausing the queue. You can load another file *into the queue* by editing the queue.

```
** Queue Loaded **  
Cannot Load File
```

Figure 4.17 File load error message when the queue is loaded

STOPPING A QUEUE

There are several ways to stop a queue, depending on what you wish to do next.



NOTE: You do not need to stop the queue in order to edit it.

Using a Hold Command

If you want to stop the pump's clock momentarily and plan to resume the run in the queue, press [MENU], and select /COMMANDS/, /Hold/, to hold the pump at the current parameters. The pump will hold until a Continue command is issued.

To resume, select /COMMANDS/, /Continue/.

Using a Pause Command

If you want to finish the current run, but then pause the queue so that the pump can run another file, or so that you can edit the Order 1 line of the queue, press [MENU] and select /QUEUE/, /Pause/. The /Pause/ selection is only present if the queue is running. Remember, you can always edit the queue itself to move a particular file into the queue, but you cannot edit the first line of the queue if the queue is running. Whenever the queue is paused, the letter Q will disappear from the Status Screen.

Use /Pause/ if you need to interrupt the running of a queue for the purpose of relegating the pump to another task. To resume running the queue, re-load the queue by selecting /QUEUE/, /Load/. When the Status Screen shows QREADY, press [RUN] to start the queue.

By Pressing [STOP]

You can stop the current run in the queue by pressing the [STOP] key. The pump will immediately stop, and the clock will be reset to zero. You may restart the same run by initializing the run file by pressing [RUN]. (The run file will be the last file in Order 1—remember, the queue automatically re-sorts the queue after all the runs of a file have been performed.) When the pump shows QREADY, restart the run as you normally would. The pump continues its operation based on the queue.

By the Pump's Clock

Another way to reset the pump's clock and to restart the current run is to press [MENU] and select /COMMANDS/, /Reset/. When the Status Screen shows QREADY, restart the run by pressing [RUN].

By Aborting a Queue

You may abort the queue by deleting it. To do this select /QUEUE/, /Delete/. The current run of a deleted queue will be completed and the file in Order 1 will remain the run file.

The Tests Menu

The Tests Menu allows you to access the pump's built-in diagnostics, part of the pump's advanced features. This section assumes that the source of the problem is known to be the SpectraSYSTEM or SpectraSERIES pump. If you are not certain that the pump is the source of trouble, refer to *General LC System Troubleshooting*, on page 121.

To access the Tests Menu, select /TESTS/ from the Main Menu (Figure 4.18):

· FILES	· QUEUE	> TESTS
· COMMANDS		· OPTIONS

Figure 4.18 Main Menu with /TESTS/ selected

The Tests Menu (Figure 4.19) consists of five items. Tests are divided into three specific menus, for convenience: diagnostic tests, calibration tests, and service tests. The Maintenance Log is described fully in Chapter 5.

> Software Version
· Diagnostics

· Maintenance Log
· Calibration
· Service

Figure 4.19 Tests Menu

ABOUT RUNNING TESTS

Tests are internal computer programs that exercise the pump's hardware and circuitry and verify operation. If any abnormal behavior is found it is reported as a message or an electronic circuit board failure code. In most cases the test isolates the problem to the failed module or component.

Active and Passive Tests

There are active and passive tests. Passive tests can be initiated at any time as they do not affect either file memory or pump performance. Passive tests are usually initiated by pressing [ENTER]. Active tests require that the pump be idle before being initiated, since the pump's valves and motor may be engaged during the test. Usually, active tests are initiated by pressing [RUN], and are

stopped by pressing [STOP]. Some tests stop by themselves. An active test should not be performed while the pump is in operation, as it will interfere with pump operation.



NOTE: Pressing [STOP] during a passive test can interrupt pump operation.

Initiating Tests

To initiate a test, move the cursor to the test's name and press [ENTER]. Always follow the instructions displayed on the pump when you initiate a test. In some cases the message, "Pump must be stopped to run test" may be displayed if you attempt to run an active test while the pump is in RUN. Alternately, if the pump is stopped when you initiate a test you may see the message, "The Pump Must Be Running to Perform This Test." In most cases, the pump will initiate an active test if the pump is in INIT, EQUIL, or READY.

Usually you will press [ENTER] to initiate a passive test, or [RUN] to initiate an active test. Some tests display instructions. In these cases, follow the instructions in the message to proceed.

Test Results

After each test is run a message appears advising you of the results of the test. In most cases, if trouble is found, the message indicates the failure or failed component. Specific test menu descriptions begin below.

Flow Stability and Hardware Series Test Routines

Under most circumstances the Flow Stability and Hardware Series tests will provide a thorough evaluation of the condition of your pump. We recommended that these two tests be used first if the performance of the pump is in question. The Flow Stability test is described on page 72 and the Hardware Series Tests is described on page 82.

SOFTWARE VERSION (PASSIVE)

Selecting /Software Version/ displays the version of software contained in the pump. The particular version of software resident in your pump will vary depending upon the date of manufacture or upon the date of software upgrade.

THE DIAGNOSTICS MENU

The Diagnostics Menu (Figure 4.20) contains three items commonly used to evaluate the pump and an additional selection to allow the pressure transducer's output to be zeroed.

```
>Flow Stability
·Measured Parameters
-----
·Check Valve Test
·Zero Pressure
```

Figure 4.20 The Diagnostics Menu

Flow Stability

Your pump is constantly monitoring its flow stability while pumping. An internal software program allows the pump to determine when flow stability has been adversely affected by leaking check valves, out-gassing solvents, or other abnormal conditions.

The Flow Stability test (a passive test) evaluates how even the solvent flow is through the pump. The pump must be pumping solvent for this test to be run. The test can be initiated when the Status Screen shows any one of these states: EQUIL, or READY (all pumps). In addition, *time*, QEQUIL, or QREADY can be displayed on the P1500 pump. Completion of the test however, is dependent on the pump being in a READY state. When the pump is not in a ready state the Flow Stability screen will read, "Not Ready". When flow stability is being evaluated, the screen will read, "Test in Progress. Please Wait."

The pump's cam must go through at least 10 pump cycles (cam revolutions) to accurately assess stability. The value displayed is affected by the compressibility of the solvent being pumped and the compliancy of the hardware (tubing, column, etc.). Therefore, the results are reported in two ways: a) an overall judgment of the pump performance which appears in the upper left-hand corner of the display and b) a number indicating where, within the range, the result lies. This number is shown in the upper right-hand corner of the display. Three flow stability readings are possible:

Stable	(0- 25)
Acceptable	(25 - 90)
Unstable	(> 90)

Unless a very volatile or compressible solvent is being pumped, for example hexane, a number near the higher end of the range (60-90) probably indicates that the system is not ideal, and the results of further troubleshooting might improve the flow stability.



NOTE: The Flow Stability Test may show unstable flow during column equilibration.

If the results of the flow stability test are abnormal for your LC application, follow these steps to locate the problem:

1. Test the integrity of the inlet and transducer check valves by running a Check Valve test. (See page 74.)
2. Verify that the mobile phase solvents are adequately degassed.
3. Refer to the recommendations of *General LC System Troubleshooting Techniques* in Appendix A, page 121.

The flow stability assessment will remain displayed until you stop the test by pressing any one of the following keys: [ENTER], [^], [MENU], or [STATUS].

Measured Parameters

Measured Parameters (a passive test) shows the measured flow rate (Figure 4.21). The number in parentheses indicates the flow rate setting in the run file. The calculated flow is based on the flow calculated during the last 360° of motor rotation.

Calc Flow	(2.00)	1.95
-----------	--------	------

Figure 4.21 An example of the Measured Parameters Menu

The measured parameters will remain on the display until the test is stopped by pressing any one of the following keys: [ENTER], [^], [MENU], or [STATUS].

Check Valve Test

The Check Valve test (an active test) can help you further diagnose the source of flow stability problems. If the results indicate a defective check valve, the test should be repeated to ensure the results were not due to an isolated transient condition, such as a single air bubble.

This test affects flow accuracy while the test is running. Do not run the test during an analysis. The pump can be in EQUIL, or READY and the flow rate must be 2.5 mL/min or less (for standard liquid ends). If the test is activated and the current flow rate is greater than 2.5 mL/min, a message will be displayed, prompting you to reset the flow rate. In general, the flow rate must be set to one-quarter or less of the maximum flow rate of the liquid ends.



HINT: Defective check valves tend to perform better at higher column pressures. Lowering the column pressure by decreasing the flow rate increases the test's sensitivity of marginally operating check valves.



NOTE: The inlet check valve is located at the base of the inlet liquid end. The transducer check valve is located at the base of the pressure transducer.

To activate the test select /Check Valve Test/. Follow the displayed instructions. A message will inform you of the 8 - 10 pump cycle delay before test completion. During this time, the condition of the inlet and transducer check valves of the pump are monitored. When the monitoring period is complete, pumping returns to normal constant flow control and a message is displayed, showing the results. Messages are listed in Table 4.1.



NOTE: Changing mobile phase concentration may cause the test to report a good check valve as defective. Stabilize composition before running the test.

Pressing [RUN] after the results are displayed will rerun the test. Stop the test by pressing [ENTER] or [^].

Table 4.1 Check Valve Test Results

Both check valves good	Both check valves are performing well.
Transducer check valve is defective	The transducer check valve should be replaced. See Chapter 5, <i>Required Maintenance</i> for instructions.
Inlet check valve may be defective	The inlet check valve may be defective. An air bubble lodged in the check valve or piston seal or a slight leak in an inlet fitting may cause this message to be displayed. Verify that solvents are adequately degassed and that fittings are tight. Purge the pump and rerun the test to verify the message. If this same message is displayed, replace the inlet check valve. See Chapter 5, <i>Required Maintenance</i> for instructions.
Bubbles or leaks likely. Check degas	The check valves are not the cause of flow problems. Verify that solvents are adequately degassed and that fittings are tight. Observe the inlet tubing while purging the pump. If air bubbles are seen, increase the helium flow rate (if helium degassing), or tighten the leaking fitting. Tighten bottle caps. Ensure solvent supply is vented.



NOTE: Pulse dampeners should not be used with SpectraSYSTEM or SpectraSERIES pumps. The flow is dynamically controlled and will be adversely affected by compliant loads.

Test aborted, Pump not referenced in 10 Cycles	The pump is not able to establish a reference column pressure within 10 pump cycles. The pump has serious flow problems. Verify that the solvents used are miscible in all concentrations encountered. If possible for your column, increase the column pressure by raising the flow rate. The check valves require more than 100 psi column pressure to operate properly. Defective check valves will usually operate well enough at higher pressures to allow the test to run.
Test aborted By Operator	The test was stopped before the pump could count 8 cycles.

Zero Pressure

The pump allows the pressure transducer's output to be zeroed automatically without the need for adjustment of potentiometers. The pump should be stopped before selecting /Zero Pressure/. The display will show:

Release system pressure,
then press ENTER key.

Figure 4.22 Release system pressure prior to zeroing the pressure transducer's output

Release the system pressure by opening the bypass valve or removing the column from the system to ensure that the transducer is actually sensing zero system pressure. Otherwise, a message showing "Unable to Zero" will appear. Follow the instructions to complete zeroing the pressure. To abort the test, press [ENTER], or [^], or [STOP]. This will return the zero setting to its previous value.

THE MAINTENANCE LOG

The Maintenance Log is fully described in Chapter 5, *Required Maintenance*.

THE CALIBRATION MENU

The Calibration Menu (Figure 4.23) contains a Flow Calibration "test". The flow Calibration can be run in one of three modes.

·Flow Calibration

Figure 4.23 The Calibration Menu

Flow Calibration

The Flow Calibration Menu performs some internal calculations based on user-measured values. This is a passive test but it uses the [RUN] key. Unless run incorrectly, this test will not interfere with pump operation. Select /Flow Calibration/ to access the flow calibration menus.

The test is run in one of three modes. Select either Meter, Fixed Volume or Fixed Time from the Flow Calibration Menu (Figure 4.24). Depending on your selection, the display will allow you to enter values that enable the test to be completed. These are described in Figure 4.24.

·Fixed Time	·Meter
·Fixed Volume	

Figure 4.24 Flow Calibration Menu

Table 4.2 Flow Calibration Modes

<u>Calibration Mode</u>	<u>Value to Enter</u>
Fixed Time	Measured Volume (mL)
Fixed Volume	Measured Time (min)
Meter	Measured Flow

Fixed Time: Measured Vol (mL)

This calibration mode assumes that you have collected and measured a specific volume pumped during a fixed time period. Selecting Fixed Time displays the Fixed Time Menu (Figure 4.25).

·Calculated Vol.	·10.0 mL
·Measured Vol.	9.5 mL

Figure 4.25 The Fixed Time Menu

(NOTE: The Measured Vol. value was artificially input to demonstrate the menu function.)

1. Enter the theoretical volume for the fixed time period in the Calculated Vol. field.
2. Enter the measured volume for the fixed time period in the Measured Vol. field.
3. Press [RUN] to initiate the test. During the test, the pump determines a new flow correction factor to compensate for the inaccuracy in the flow rate. The Flow Correction Menu displays the results of the test. Figure 4.26 shows example results.

OLD	Flow Correction	NEW
100.00%	Use	101.00%

Figure 4.26 The Flow Correction Menu with example fixed time calibration results

OLD: The previous flow rate correction factor default or from a previous flow calibration test.

NEW: The new flow rate correction factor based on the Measured Vol. value.

Flow Correction: Use the [+] / [-] keys and press [ENTER] to select one of three choices:

Use: Use NEW flow correction factor. The factor remains in effect until you turn off the pump or initiated the NOVRAM.

Save: Save_NEW flow correction factor to NOVRAM. This factor remains in effect until you save a different value over it, or until you reinitialize the NOVRAM (TESTS/SERVICE/Test 271). Test 271 replaces this value with the default flow correction factor.

Scrap: Discard the NEW (previous) flow calibration factor and keep the current value.

Press [RUN] to complete the test.

Fixed Volume: Measured Time (min).

This calibration mode assumes that you have externally timed the period in which a specific volume has been pumped.

Selecting Fixed Volume displays the Fixed Volume Menu (Figure 4.27).

·Calculated Time.	·10.00 min
·Measured Time	9.50 min

Figure 4.27 The Fixed Volume Menu

(NOTE: The Measured Time value was artificially input to demonstrate the menu function.)

1. Enter the theoretical time period for the fixed volume in the Calculated time field.
2. Enter the measured time for the fixed volume in the Measured Time field.
3. Press [RUN] to initiate the test. During the test the pump determines a new flow correction factor to compensate for the flow rate inaccuracy.

OLD	Flow Correction	NEW
100.00%	Use	101.00%

Figure 4.28 The Flow Correction Menu with example fixed volume calibration results

OLD: The previous flow rate correction factor default or from a previous flow calibration test.

NEW: The new flow rate correction factor based on the Measured Vol. value.

Flow Correction: Use the [+] / [-] keys and press [ENTER] to select Use, Save, or Scrap as described above.

4. Use the [+] / [-] keys to choose Use, Save, or Scrap.

5. Press [RUN] to complete the test.

Meter: Measured Flow (mL/min)

This calibration mode assumes that you have externally measured the precise flow rate that the pump is operating at while set at a specific flow rate.

Selecting /Meter/ displays the Meter Menu (Figure 4.29).

·Selected Flow.	·1.00 Mn
·Measured Flow	1.00 Mn

Figure 4.29 The /Meter/ Menu

(NOTE: The Measured Time value was artificially input to demonstrate the menu function.)

1. Enter the set flow in the Selected Flow field.
2. Enter the measured flow in the Measured Flow field.
3. Press [RUN] to initiate the test. During the test the pump determines a new flow correction factor to compensate for the inaccuracy in the flow. The Flow Correction Menu displays the results of the test. Figure 4.30 shows example results.

OLD	Flow Correction	NEW
100.00%	Use	101.00%

Figure 4.30 The Flow Correction Menu with example fixed volume calibration results

4. Use the [+]/[-] keys to choose Use, Save or Scrap as described for the Fixed Time Menu.
5. Press [RUN] to complete the test.

To exit the flow calibration menus without entering any values, press [^] until you return to the Calibration Menu.



NOTE: Do not press [STOP] unless you have already entered a new value in one of the flow calibration menus. If the pump is in RUN, doing so will interfere with your analysis. Use [^] to exit the flow calibration menus instead.

THE SERVICE MENU

The Service Menu (Figure 4.31) contains several service-related tests, including the Hardware Series test.

>Current History	
·Lifetime History	

·ROM Test	(200)
·RAM Test	(201)
·Cycle Step Count	(205)
·External Inputs	(206)
·Display Test	(208)
·Transducer Range	(209)
·Motor Step/Valve	(211)
·Hardware Series	(220)
·Initialize NOVRAM	(271)

Figure 4.31 The Service Menu

The numbers in parentheses refer to a similar test found in earlier SpectraSYSTEM pumps. They are included for the convenience of users and service personnel familiar with this previously-used numbering scheme.

Current History

By selecting /Current History/ you access a chronological list of operating state changes. The negative number on the far left indicates the time (in minutes) between the time the Current History Menu was accessed and the state change occurred. More specific information about reading the Current History Menu is found in the *SpectraSYSTEM Pumps Field Repair Manual*.

To exit the Current History, press [ENTER].

Lifetime History

By selecting /Lifetime History/ you access a log of five measured items relating to the entire time the pump has been in operation. An example Lifetime History Menu is shown in Figure 4.32.

The top line shows 1) the total time that the pump's motor has been running in hours (Hr) and 2) the total number of strokes in thousands (kSt) taken by the cam; the bottom line shows 3) the number of times the pump has been powered-on (on), 4) the number of times the pump has been powered-down (off), and 5) the number of times an error occurred when NOVRAM was written to upon power-down (bad).

Press any one of the following keys to exit the Lifetime History screen: [ENTER], [^], [MENU], or [STATUS].

1.2 Hr	2.3kSt
24on	23off
	0bad

Figure 4.32 The Lifetime History Menu

**ROM Test
(Passive)**

The ROM test (200) verifies the integrity of the ROM (Read Only Memory) in your pump. The ROM is where all of the built-in programs for the pump operation are stored. If faults are found in any part of ROM, a message indicating that the test has failed will be displayed. Press [STOP] to stop this test. Do not to press [STOP] more than once or else pump operation will be interfered with.

If a failure is indicated, contact Thermo Electron.

**RAM Test
(Active)**

The RAM test (201) verifies the integrity of the RAM (Random Access Memory) in your pump. The RAM is where your pump files are stored and where temporary calculations are performed. The pump must be stopped (STOP) for this test to be implemented. If any faults are found with RAM, the message shown in Figure 4.33 is displayed.

RAM TEST failed

Figure 4.33 RAM Test failure message

Contact Thermo Electron if this test indicates a failure.

**Cycle Step
Count (Passive)**

Normally, 12,800 motor drive pulses are required for one revolution of the pump motor, as detected by the cam sensor. The Cycle Step Count test (205) displays a count of the number of pulses required for the last complete motor revolution.

The Cycle Step Count test is a dynamic measurement of the number of steps counted, the lag amount (the number of steps the count has shifted since the last revolution), and the number of seconds required for the last revolution.

Generally, the number of steps should be $12,800 \pm 64$. The lag value varies due to the load on the pump. This number should be steady, or fluctuate no more than ± 120 steps.

Start the test by selecting /Cycle Step Count/. To stop the test, press any one of the following keys: [ENTER], [^], [MENU], or [STATUS].



NOTE: The Cycle Step Count test requires that a full cam revolution has occurred.

External Inputs (Passive)

The External Inputs test (206) allows you to conveniently monitor the status of two of the external input lines, STOP and RUN. The STOP line causes the pump to stop pumping when momentarily grounded. A momentary ground at the RUN input line causes the run time clock to begin. Use this test if you are having difficulty interfacing your pump to a controlling device, such as a SpectraSYSTEM autosampler.

To run the test, select /External Inputs/. The display continuously shows the current state of the STOP and RUN inputs (updates every 0.5 second). "Lo" means the input is grounded (active) and "Hi" means the input is "high" (inactive).

To stop the test, press either [ENTER], [^], [MENU], or [STATUS].

Display Test (Passive)

The Display test (208) exercises the pump's display. When initiated, the display shows staggered alphanumeric characters that scroll from left to right. Pressing [STOP] freezes the display; pressing [RUN] resumes movement.

This test is also a keyboard test. Pressing the cursor keys will cause the alphanumeric display to scroll in that direction.

Other keys can be tested by first pressing [ENTER] to access the key test. The display will verify other keys such as [STATUS] or [MENU], as soon as each is pressed.

To return to the scrolling alphanumeric characters, press [RUN], [RUN]. To stop the test, and return to the Service Test Menu, press [STOP], [STOP].

Contact your representative if the display appears unusual.

Transducer Range (Active)

Transducer Range is not truly a test. It contains a field where you must enter the calibration value (in mV) for a replaced pressure transducer. The range is located on the replacement transducer wire. Your pump features advanced circuit designs which allow the pressure transducer range adjustment to be set by entering a value from the keyboard. No adjustment of potentiometers is necessary. Your pump comes from the factory preset to the proper range. The value is stored in a NOVRAM. Do not change the transducer calibration setting unless the pressure transducer or System PCB are replaced. The calibration number is recorded on a tag attached to the transducer cable. The System PCB and pressure transducer are not user-serviceable parts. A qualified service representative must perform any repair or replacement.

Motor Step/Valve (Active)

The Motor Step/Valve test (211) exercises the pump motor and the switching valve on the P1500. When activated, the pump motor is continuously stepped and each switching valve is sequentially opened and closed at a rate of 1 valve per 0.512 seconds. This test is useful for detecting an intermittently failing switching valve or pump motor.

Select /Motor Step Valve/ to initiate the test. Follow the instructions. Each open valve is shown dynamically on the display. The test will continue until one of the following keys is pressed: [ENTER], [^], [STOP], [MENU], or [STATUS].

Hardware Series (Active)

The Hardware Series test (220) is an extensive evaluation of the System Printed Circuit Board (PCB), switching valve, pump motor, and pressure transducer. The System PCB contains all of the circuitry for the operation of the pump, except for the display functions. Once activated, the test exercises and diagnoses the condition of various circuits. The pump must be idle (not pumping) before activating the test. This test will not affect pump files.



NOTE: The external events connector (if present) must be removed from the rear of the pump before initiating the Hardware Series test. Otherwise, "Board Failure: Code 8" may occur.

To activate the test, select /Hardware Series/. Follow the instructions given on the display. Typically, the display will show:

Release system pressure
Then press ENTER.

Figure 4.34 Initial Hardware Series test message

Open the column bypass valve or otherwise remove column pressure from the transducer since the pump will operate during the test and an excessively high column pressure might be generated if not bypassed. Press [ENTER] to continue the test.

Once the test is activated the display will appear as in Figure 4.35.

Test in Progress

Figure 4.35 Hardware Series test message, after pressing [ENTER]

The pump's components are tested in the following order.

1. Pressure transducer and circuitry
2. Input/output ports
3. Solvent switching valve and circuitry (P1500 only)
4. Motor drive circuitry
5. Cam marker and circuitry
6. Motor revolution and sine/cosine circuitry

As each portion of the test is completed a message is displayed. If all components and circuitry are within specifications, the messages shown in Figure 4.36 are displayed during the test.

If a failure is detected during the test, the failure message is displayed. It remains displayed until [ENTER] is pressed (the test resumes).

To stop the test, press [STOP], or press [^] to return to the Service Menu.

```
TRANSDUCER TEST PASSED
-----
PORT TEST PASSED
-----
VALVE TEST PASSED ** (P1500 only)
-----
MOTOR DRIVE TEST PASSED
-----
CAM MARKER TEST PASSED
-----
REVOLUTION TEST PASSED
-----
Hardware series tests completed - PASSED
```

Figure 4.36 No problems found during the Hardware Series test.

If problems are found during the test, a message suggesting the most likely failure is displayed, although in some cases other failures are possible. The messages shown in Table 4.3 indicate a possible System PCB failure.

Table 4.3 Errors indicating possible System PCBA failure

BOARD FAILURE: CODE XXX	If the failure is identified as a component on the system printed circuit board or if the test cannot determine the failed component, a message is reported where XXX is a 1-, 2- or 3- digit number.
8	Remove the external events connector from the rear of the pump. This test exercises the input lines and may be affected by attached cabling.
1-100	Pertains to failures of the system printed circuit board. Contact your service representative.
101, 102, 103	(P1500 only) Indicates the switching valve's electrical system has failed. Refer to Chapter 5, under <i>Solvent Switching Valve Replacement</i> .
104, 105	Possible broken or loose pump motor cable wire.
124	Too many motor steps were needed to complete a cam revolution. You may have a loose motor coupler or faulty System PCB. Contact your local sales/service representative for service information.
125	Too few motor steps were needed to complete a cam revolution. You may have a faulty cam sensor or System PCB. Contact your local sales/service representative for service information.
TRANSDUCER UNPLUGGED	The pressure transducer was not detected. The connector going to the pressure transducer should be checked. Access to this connector requires the removal of the pump's outer protective cover. Because there are safety issues involved in its removal, this should only be performed by a qualified service technician. The location of this connector as well as the proper procedure for removing the outer cover are outlined in the Field Repair Manual.
CANNOT ZERO TRANSDUCER	The transducer circuitry is not able to compensate for the zero offset of the transducer. Make sure that the system is at zero column pressure (column bypassed) before starting the test. If so, replace the transducer. Contact your local sales/service representative for assistance.
CHECK FUSE F1	(P1500 only) Fuse F1 is used to protect the valve drive circuitry from internally shorted valves which may short internal circuitry on the system PCB. Checking the status of F1 requires the removal of the outer cover of the pump. Because of safety issues involved in the removal of this cover a trained service technician should perform this evaluation. Contact your local sales/service representative for assistance.
CAM MARKER NOT FOUND	This message indicates that the sensor that detects cam revolutions is not operational. Either the motor coupling is loose or the cam sensor is defective. This requires tightening of the motor-to cam coupler if loose, or replacement of the cam sensor. Both of these actions require the removal of the top cover. Because of safety issues involved in the removal of this cover a trained service technician should perform this evaluation.

Table 4.3 Errors indicating possible System PCBA failure, *continued*

VALVE CABLE UNPLUGGED	<i>(P1500 only)</i> The test has detected that the solvent switching valve cable is disconnected from the System PCB. There are two locations where the valve is connected. The first location is underneath the switching valve assembly. To access this location the switching valve must first be removed. This is achieved by unscrewing the finger-tight captive fasteners which hold the assembly in place. Once this is accomplished the cable connector is visible. Press together the connector attached to the cable coming from the switching valve assembly to the mating connector located nearby in the chassis of the pump. If this fails to remedy the problem then the second cable connection location should be checked. Correction of the problem at this second location requires the removal of the top cover. Because of safety issues involved in the removal of this cover a trained service technician should perform corrective action.
CAM SENSOR FAILURE	The cam sensor cable is disconnected or defective and needs to be replaced. Correction of this problem requires the removal of the top cover. Because of safety issues involved in the removal of this cover a trained service technician should perform corrective action. Contact your local sales/service representative for service information.
NO CURRENT TO MOTOR	The test has detected no current flow through the pump motor. Either the motor cable is unplugged on the System PCB or the entire drive circuitry is defective. Correction of this problem requires the removal of the top cover. Because of safety issues involved in the removal of this cover a trained service technician should perform corrective action. Contact your local sales/service representative for information on obtaining a replacement.

Initialize NOVRAM (Active)

The pump must be stopped for /Initialize NOVRAM/ to be completed.



NOTE: Initialize NOVRAM (271) has a profound effect upon the pump's non-volatile RAM. Do not initialize the NOVRAM unless you fully understand all consequences associated with this action.

By initializing the NOVRAM all files are reset to their default values, with the exception of the run file. All user-preferences set in /OPTIONS/ are also returned to their default values. In addition, any changes that had been made to the Liquid End Type and Flow Calibration parameters are erased, and these selections are returned to their default values.

In general, any field value or selection that is normally retained when the pump is turned off and then on will be reset to its default value when the NOVRAM is initialized.



NOTE: The pressure transducer's range value is not reset when the NOVRAM is initialized.



HINT: To retain a single file while initializing the NOVRAM: load it (so that it becomes the run file), stop the pump, initialize NOVRAM, make a change to a value within the run file from Status, then select /Save File/ at the bottom of the Status Menu.

5

Required Maintenance

Introduction

When properly maintained, your Thermo Electron pump will provide years of trouble-free operation. It is important that your pump receive routine preventive maintenance to ensure reliability and optimum performance. Properly performed routine, preventive maintenance also helps keep your warranty valid. Your pump is designed to encourage proper maintenance by making maintenance parts easy to access, replace and record.

This chapter describes the Maintenance Log Menu and how to use it. Some hints to help you extend the maintenance period of your pump are also included. Easy-to-follow, step-by-step required maintenance procedures are also contained in this chapter so that you can keep your pump in optimum working condition. A few maintenance tips for parts of the pump not directly involved with solvent flow follow the maintenance procedures. The last section contains replacement procedures for two user-serviceable parts: fuses and the solvent switching valve.



NOTE: Maintenance of the pump is the responsibility of the user. Routine maintenance is not provided under warranty. However, planned maintenance contracts are generally available. Please contact your local representative if you are interested in purchasing a planned maintenance contract.

THE BENEFITS OF PROPER MAINTENANCE

As with most things, there is tremendous benefit in doing things right the first time. For example, an unusually fast seal failure may indicate either incorrect installation or a scratched piston. A scratched piston may be caused by improper installation of the seal or piston, by allowing the pump to sit idle with a buffered eluant in it, or by failing to filter your eluants.

Maintenance Schedule

Table 5.1 Gradient Pump Preventative Maintenance Schedule

Frequency	Procedure	Performed By
Daily	Check waste reservoir. Empty as required.	User
	Check solvent reservoir. Replenish as required.	User
Annually	Replace piston seals.	User
	Replace backflush seal. Check pistons and Kel-F seals. Sonicate any parts as required.	User

Maintenance Log

The Maintenance Log provides a convenient way for you to record maintenance performed on the liquid ends and set intervals for periodic maintenance. When a maintenance interval has been exceeded the pump will automatically display a message indicating that maintenance may need to be performed.

MAINTENANCE LOG MENU

The Maintenance Log is accessed by selecting /TESTS/ from the Main Menu, then selecting /Maintenance Log/ (Figure 5.1 and Figure 5.2).

·FILES	·QUEUE	>TESTS
·COMMANDS	·OPTIONS	

Figure 5.1 Main Menu with TESTS selected

·Software Version
·Diagnostics

>Maintenance Log
·Calibration
·Service

Figure 5.2 Tests Menu with Maintenance Log selected

The Maintenance Log Menu (See Figure 5.3) consists of a table, used to record dates and volumes, followed by one field used to enter a value relating to flow, and two additional menu items. All of these are described in this section.

ITEM	DATE	DUE	VOL
Seal1	8 AUG95	200	201

Seal2	8 AUG95	200	201
Piston1	18AUG95	600	400
Piston2	18AUG95	600	400
Inlet	8 AUG95	600	201
X-ducer	8 AUG95	600	201
·Maintenance Position			
·Liquid End Type			

Figure 5.3 Maintenance Log Menu

The Maintenance Table

The top half of the Maintenance Log Menu is a table. (Figure 5.3)

ITEM, DATE, DUE, and VOL

The ITEM field remains fixed. "Seal 1" and "Seal 2" should be paired with "Piston 1" and "Piston 2", respectively, to identify the inlet and outlet liquid ends. "Inlet" refers to the inlet check valve, while "X-ducer" refers to the transducer check valve.

Enter the date (day/month/year) in the DATE field for the last time maintenance was performed on each item.

The pump keeps "liters pumped" counters, in the VOL (volume) field, for each major maintenance item (the pump seals, pistons, and check valves). You may set a DUE volume in liters for each item. When the DUE volume is exceeded by the volume of liters pumped (VOL), the reminder "MAINTENANCE DUE - SEE PUMP LOG" is displayed. This message will appear each time a file is initialized. You may choose to use this feature to set regular intervals for maintenance, such as seal changes, pump/column cleaning, or simply to serve as a reminder to verify that the system is operating properly. The interval remains set until either the date has been updated or the DUE value has been increased.

In the example shown in Figure 5.3, a fairly complete maintenance was done on 8 Aug 95, when both seals and check valves were replaced.

Setting Intervals

The volume of mobile phase that you can expect to pump before the pump requires maintenance is very dependent upon the eluant being pumped and your adherence to good chromatographic practices. To obtain the maximum lifetime and best performance from your pump, read *Extending the Maintenance Period* on page 94. Pump pistons and check valves have been known to last for years. Even the seals themselves can last more than a year for some applications.

An initial guideline for setting up your Maintenance Log for the first time is to set both seal DUE counters to 200 liters, and the check valve and piston DUE counters to 600 liters. Setting a value of zero (0) for any DUE interval inactivates the Maintenance Log for that specific item. To inactivate the entire Log, a zero (0) must be entered for all DUE intervals. Your specific maintenance interval can be determined by observing pump performance over time.

When a Maintenance Message is Displayed

Whenever the interval has been exceeded, and the message "MAINTENANCE DUE - SEE PUMP LOG" is displayed, you should either verify that the pump needs maintenance or that the pump is operating properly. If a maintenance interval is exceeded and you find that the pump does not require maintenance, increase the DUE interval by another 50 liters from the previous setting. Once you have established an expected interval for your system, use that interval for routine preventive care.

If you find that the interval before component failure is either unacceptable or variable, then the source of the problem must be identified. Read this chapter and Appendix A. Poor chromatographic practices are by far the most common source of problems. Specific procedures for inspecting and changing parts begin on page 95.

Maintenance Position

Selecting /Maintenance Position/ prepares the pump for liquid end removal or replacement. The display shown in Figure 5.4 appears:

To install or remove liquid ends press ENTER

Figure 5.4 Maintenance position message

The maintenance position puts the pump's cam into a position to facilitate liquid end removal.

Liquid End Type

The Liquid End Type Menu allows you to select the proper liquid end for a specific application.. Do not change the flow range unless you are installing liquid ends with capacities different from those purchased with the pump.

Liquid End Type	Normal
Flow Range	0 - 10 mL/Min

Figure 5.5 Liquid End Type Menu

Selecting Normal, Bio, or SemiPrp

If you select Normal, Bio, or SemiPrp (semi prep) in the Liquid End Type field, the Flow Range field changes automatically to corresponds to the preset ranges for these Thermo Electron liquid ends. (Normal = 0 - 10 mL/min, SemiPrp = 0 - 30 mL/min, Bio = 0 - 10 mL/min, and Other.

Selecting Other

If you select Other in the Liquid End Type field, the Flow Range field becomes active, allowing you to enter your own flow range.

After changing the liquid end type on the display, press [ENTER]. A message (Figure 5.6) will prompt you to write down the old values in the Maintenance Log which correspond to the liquid ends you presumably just removed. It is important to keep records for each set of liquid ends you use. If you reinstall the "old" liquid ends, you will need to reenter the dates and statistics for the "old" ends into the Maintenance Log table. You are also reminded to enter new values into the log's VOL field, which correspond to the newly installed liquid ends. Normally the VOL field is not edited, but when new liquid ends are installed, ensure that the VOL fields for the appropriate maintenance items are reset to 0.

Write down old values
ENTER new values in log

Figure 5.6 Reminder to keep proper records when liquid ends are changed

Flow Correction

An additional menu appears whenever you press an arrow key, [ENTER], or [+]/ [-] from the display shown in Figure 5.7. This menu allows you to set a Flow Correction, if desired. OLD and NEW values are displayed. For no Flow Correction, enter 100.00%.



NOTE: The Flow Correction menu is the same as the menu displayed when a flow calibration (/TESTS/, /Calibration/, /Flow Calibration/) has been initiated, except that it does not include the Use, Save, or Scrap option.

OLD	Flow Correction	NEW
100.00%		100.00%

Figure 5.7 Flow Correction Menu

Flow correction is a value, in percent, which adjusts the actual volume that the pump delivers. As you use the pump, you may feel that although the pump is set at a specific flow rate, for example 2 mL/min, the pump actually delivers slightly more or less than this volume per minute. This can be due to a variety of maintenance- or LC-related reasons (seals, valves, etc.).

If desired, manually enter a flow correction value. This value can be entered automatically, based on the result of the flow calibration test, initiated from /TESTS/, /Calibration/, /Flow Calibration/. This test [which requires you to enter an accurately measured operation value (time, volume or flow rate)] is fully explained in Chapter 4.

If no correction to the flow is desired, enter a value of 100% in this field. Values from 90% to 110% are valid. For example, if you pump for one minute at 1 mL/min and collect 0.95 mL, then the pump is actually delivering 5% less solvent than expected. To compensate, enter 105.26% in the Flow Correction field. The pump's Status Screen will still display a flow rate of 1.0 mL/min, but the pump will actually deliver 105.26% of what it normally delivers at 1.0 mL/min.

Press [ENTER] to save the value, or simply leave the menu by pressing an arrow key.

Extending the Maintenance Period

As mentioned earlier, the volume of mobile phase you can expect to pump before maintenance is due is very much dependent on the way that the pump is being used. Following these guidelines helps you extend the life and improve the performance of your pump.

- Use high quality, spectro-grade or HPLC-grade solvents. These solvents do not usually need to be filtered before use.
- Filter water and prepared solvents through at least a 0.45-micron filter before placing them in the solvent reservoirs to remove particulate matter and organic contamination.
- Avoid pH extremes. Thermo Electron offers an inert/biocompatible pump for mobile phases that are outside the pH range of 2.2 to 8.0.
- Verify that the solvents used are miscible in all proportions. This is very important for a buffered mobile phase. Precipitation of salts quickly damages maintenance parts.
- Never leave the pump filled with buffered solvent when not pumping. Either lower the flow to 0.1 mL/min. or thoroughly flush the pump. Flush with at least 25 mL of pure filtered water.
- The pump should be filled with methanol if it is to be left idle for more than two days. This avoids the possible growth of organisms in aqueous solvent systems.
- Never use hydrochloric acids solutions.
- Avoid metal ions that can cause corrosion due to electrochemical processes. Typical metal ions to avoid: manganese, chromium, nickel, copper, iron, molybdenum.



NOTE: The inert/biocompatible version of the P1500 can pump metal ions and other corrosive solvent systems. Contact your Thermo Electron sales representative for more information

Maintenance Procedures

SAFETY PRECAUTIONS

Observe the following safety precautions whenever performing periodic maintenance.



Caution!

A caution alerts you to situations that could result in personal injury. It also tells you how to avoid them.



High Voltage!

This icon alerts you to the presence of high voltage and to the potential injury that could occur from electrical shock were you to come in contact with a specific instrument area or component. It also tells you how to avoid contact with the high-voltage areas in your instrument.



Hot Surface!

This icon alerts you to potential injury that could occur from coming in contact with a heated surface or area on or in an instrument. It also tells you how to avoid contact with the heated surfaces in your instrument.

This section includes procedures for:

- Complete liquid end maintenance (includes disassembly and assembly)
- Check valve replacement
- Passivating stainless steel parts

Also included are maintenance tips for pump parts that are not involved with pump flow.

TOOLS

The following tools are useful to have on-hand as you perform maintenance procedures.

- Tweezers
- Open-end wrenches (1/4-inch, 5/16-inch, 1/2-inch)
- Loupe or magnifying glass
- Allen wrench (Hex head) 9/64-inch

PREPARATION

Prepare the pump for maintenance before performing any maintenance procedure.

To prepare the pump for maintenance, flush the pump with 25 mL of methanol. If an incompatible solvent is resident in the pump, flush with appropriate intermediate solvents before flushing with methanol. For example, if chloroform is being used as the mobile phase solvent, an intermediate flush of 25 mL methylene chloride would be appropriate before flushing with methanol.

LIQUID END MAINTENANCE

Complete liquid end maintenance includes procedures for seal and piston maintenance:

- Removal
- Disassembly
 - inspection for contamination
 - cleaning
 - piston inspection
 - cleaning/replacing parts if necessary
- Assembly
- Installation

For thorough cleaning, piston replacement, or total liquid end reconditioning, the liquid ends must be removed.

Having a second set of reconditioned liquid ends on hand for quick replacement will save additional time and allow maintenance to be performed at your convenience. Contact your local Thermo Electron representative if you are interested in obtaining spare components. Part numbers are included in Appendix C.



NOTE: Keep the liquid end components as clean as possible. Contamination decreases seal life significantly.

Preparation

1. Flush your pump with 25 mL prior to disassembling your liquid ends. If methanol is not compatible with the mobile phase in your pump, flush the system with 25 mL of an intermediate solvent before flushing with methanol.
2. Remove the front cover, exposing the liquid ends (Figure 5.8).

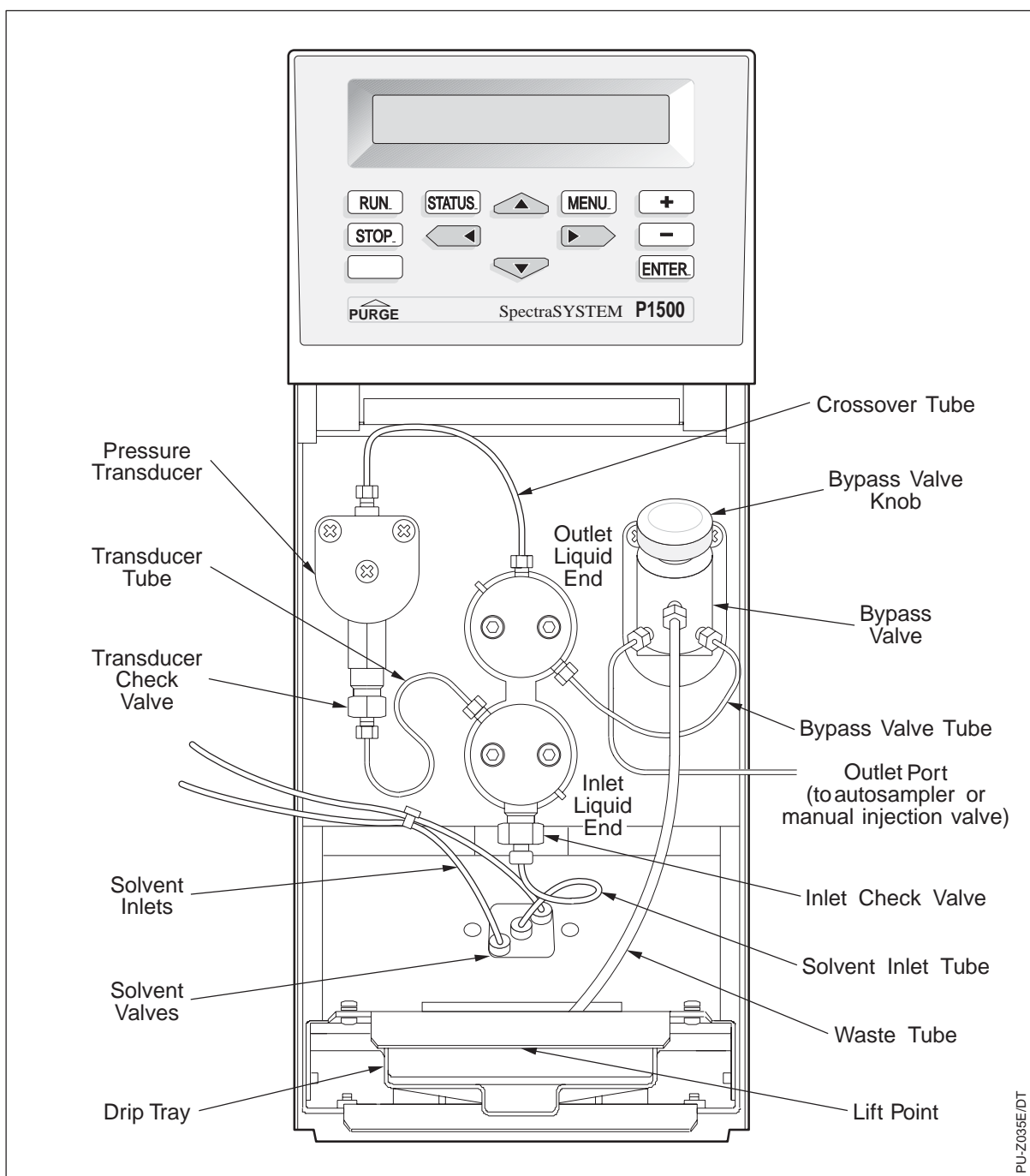


Figure 5.8 Pump with front cover removed

Liquid End Removal

To remove the liquid ends from the pump:

1. Remove all tubing attached to the pump heads. Turn the nuts counter-clockwise to remove (Figure 5.9).

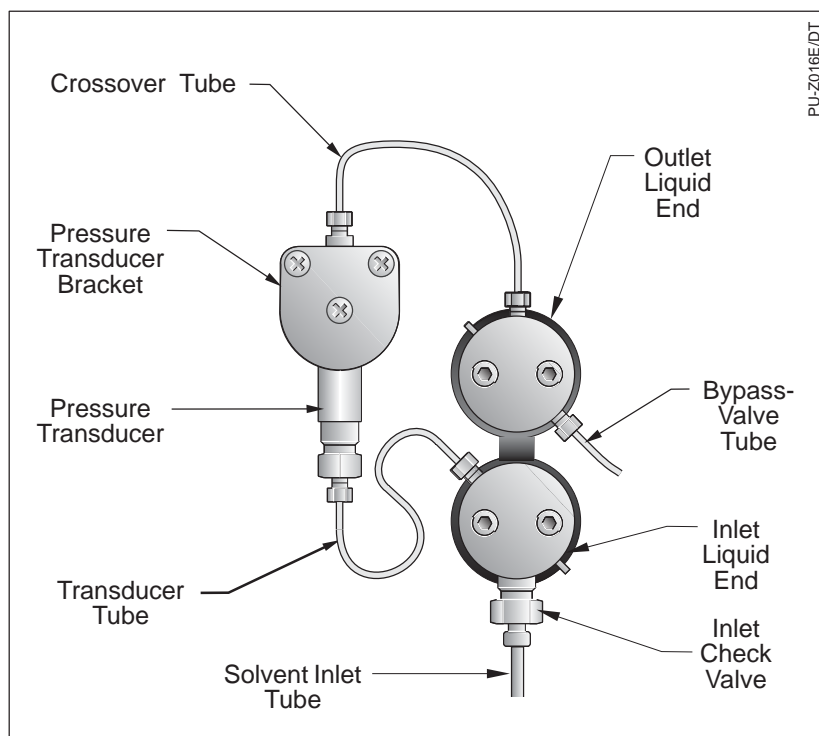


Figure 5.9 Liquid ends and tubing

2. Position the pump cam to enable the liquid ends to be removed. To do this, press [MENU], and select /TESTS/, /Maintenance Log/. Then move the cursor to /Maintenance Position/ and press [ENTER]. The display shown in Figure 5.10 appears.

To install or remove liquid ends, press ENTER
--

Figure 5.10 Maintenance position message

Press [ENTER] to continue. The pump motor rotates for a few seconds and then is electrically locked into position. While the motor rotates the display appears as in Figure 5.11. When the cam is in the maintenance position, the display in Figure 5.12 appears.

Install or remove liquid ends when motor stops

Figure 5.11 The display when the motor moves cam to maintenance position

X-ducer	(date)	(due)	(vol)
· Maintenance Position			

Figure 5.12 The display after the motor moves the cam to the maintenance position

The pump is now in its maintenance position. It will hold this position (if power is maintained) until a file is initialized or a purge is started.

3. Remove the inlet check valve (Figure 5.13) from the inlet pump head.



NOTE: It is not necessary to remove the check valve to replace a piston, however, it is easier to remove at this time if total liquid end reconditioning is to be performed.

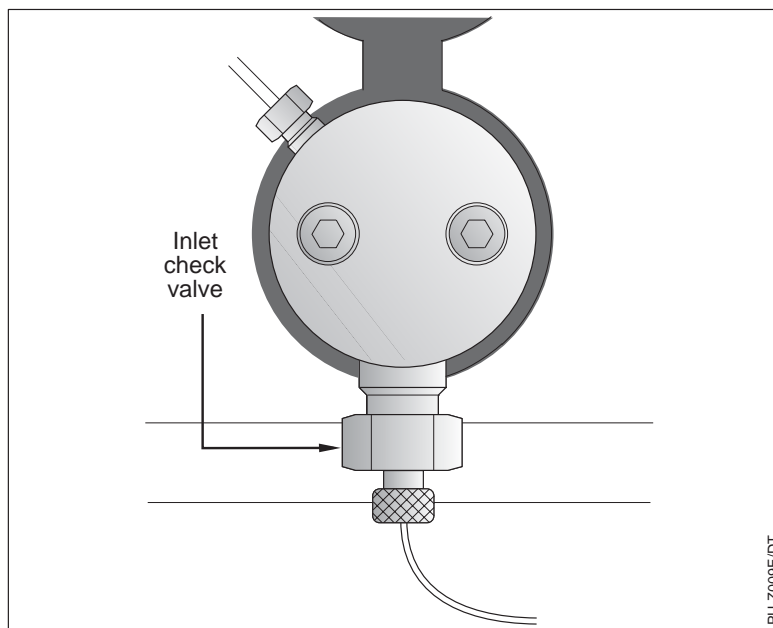


Figure 5.13 Inlet check valve

4. Push in the outlet (upper) liquid end and rotate it (90 degrees counter clockwise) until it releases from the pump module. Remove the liquid end and set it aside.
5. Push in the inlet (lower) liquid end and rotate it (90 degrees clockwise) until it releases from the pump module. Remove it and set it aside.

Liquid End Disassembly

To disassemble the liquid ends:

1. Separate the pump head from the piston holder housing by removing the two 9/64-inch hex cap screws. Turn the screws counter-clockwise.
2. Examine the Kel-F® seal in the cylinder bore. If the seal is damaged (scratched, warped or torn) it must be removed. Use tweezers to remove it by pulling gently on the seal's inner circumference. (Be careful not to scratch the cylinder surface!)
3. Examine the pump head for contamination. Flush the pump head with methanol or place it into an ultrasonic bath.
4. Remove the seal holder from the piston holder housing by grasping both ends of the exposed tube, and pulling gently (Figure 5.14).

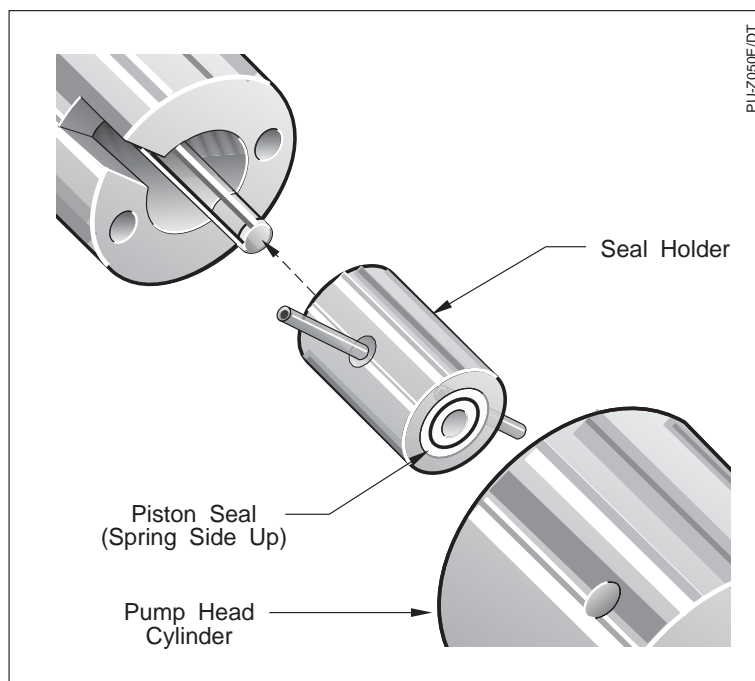


Figure 5.14 Removing the seal holder from the piston holder housing

5. Carefully remove the piston seals from the seal holders using the seal removal tool supplied in the accessory kit. Insert the tool and wiggle it in a circular manner to remove the seal. (See Figure 5.15). Flush the holders with methanol if contamination is present.

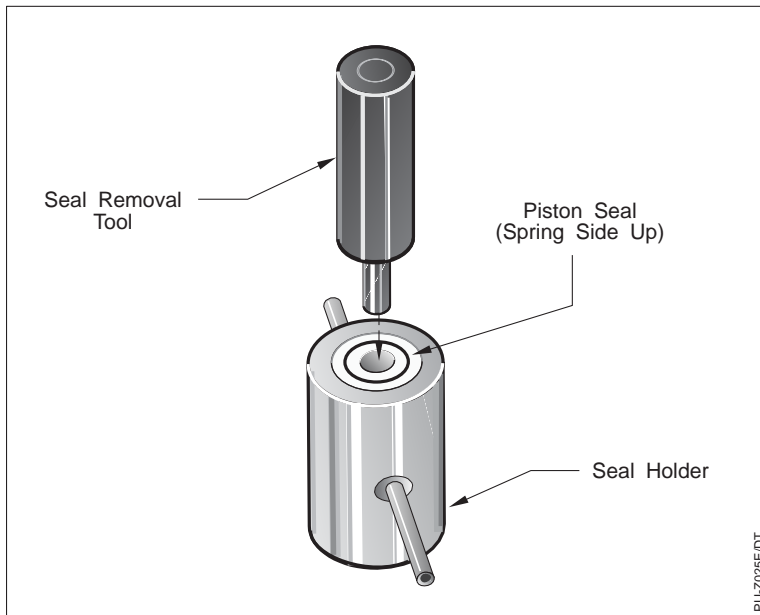


Figure 5.15 Using the seal removal tool

6. While retaining the piston holder, remove the 9/64-inch retaining cap screw (Figure 5.15). This allows the piston holder to be removed from the piston holder housing. Separate the holder, piston, spring and housing.



NOTE: The piston components are spring loaded and may shoot out!
(Figure 5.17)

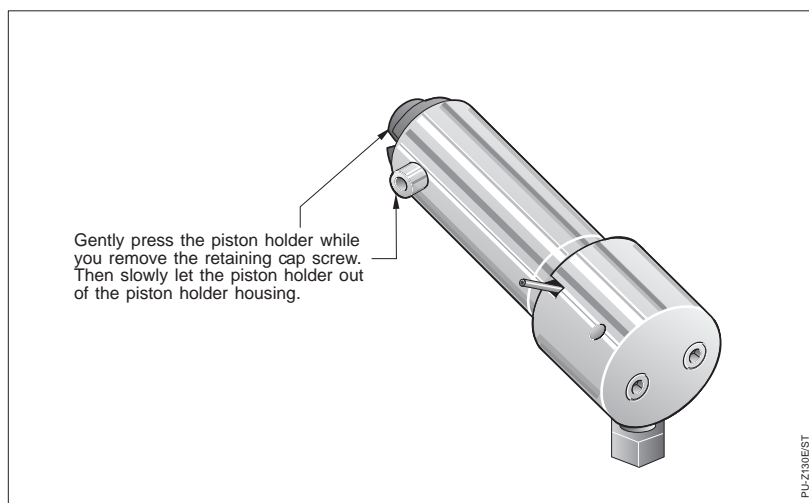


Figure 5.16 Retaining the piston holder

7. Examine all parts for wear, corrosion or contamination. Clean all deposits. Look for wear marks on the stainless steel shaft of the piston and corresponding wear marks on the inner aspects of the spring which indicate bending or bowing. If these wear marks are present, replace the spring (Figure 5.17).



NOTE: It is normal for the piston holder to produce a small amount of wear particles.

8. Examine the piston carefully under a low-power microscope or magnifying glass for fine scratches, ridges, or scoring which can reduce seal life (Figure 5.18). Some apparent scratches are actually cleanable deposits. The piston can be cleaned by wiping it gently with a laboratory towlette or cotton swab that has been immersed in methanol. Replace the piston if scratched or pitted. The new piston should also be cleaned prior to installation.

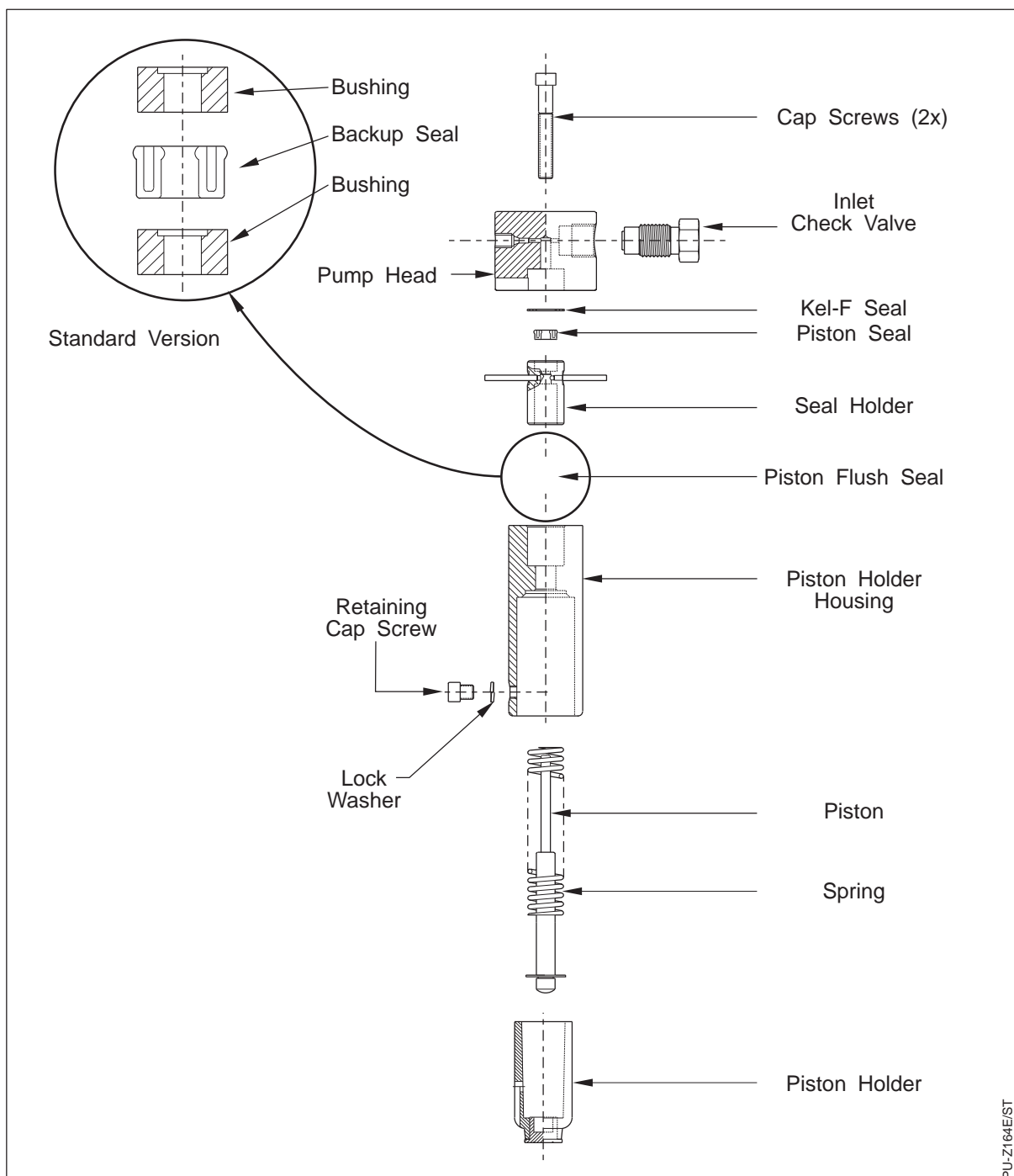


Figure 5.17 Liquid end components

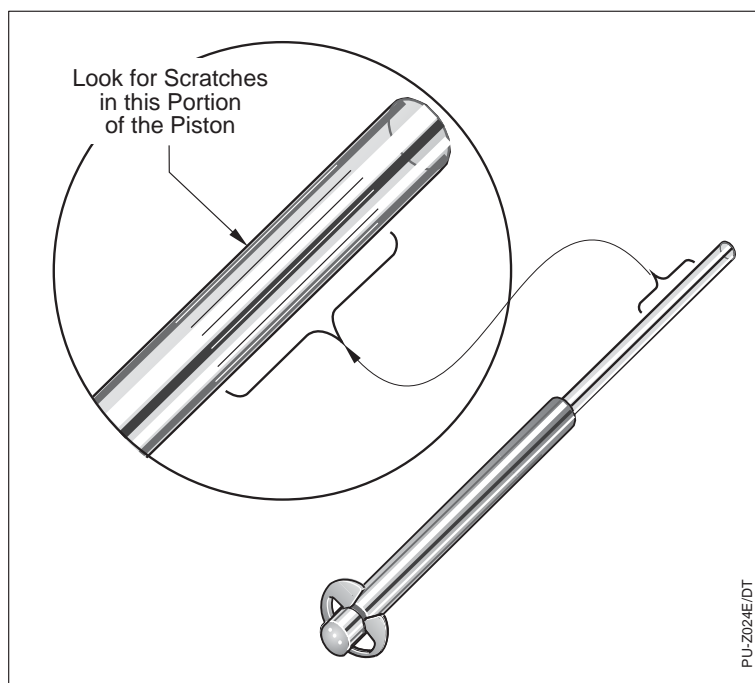


Figure 5.18 Piston scratches (under magnification)

9. Thoroughly flush all components with methanol.

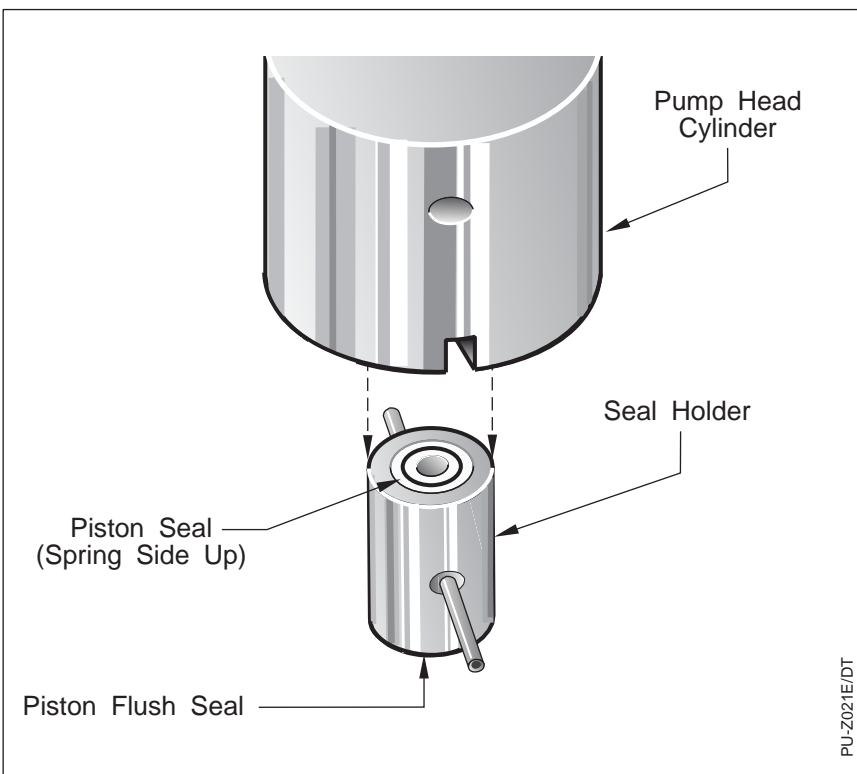
Liquid End Assembly

To replace the piston seal and reassemble the liquid end:

1. Place the seal holder on end on a clean, flat surface. Place the seal holder into the pump head with the seal down (spring should face the inside of the pump head.) Install new piston seals by setting them in position on the seal holder (spring side up) and gently pressing them into place with the pump head (Figure 5.19).



NOTE: It is possible to install the seal in the wrong end of the seal holder. If installed in the wrong end, the seal will not be flush with the top of the holder. The opposite end of the seal holder is deeper, to accommodate the piston flush seal. Install the piston seal only in the end closest to the tubes.



PU-Z021E/DT

Figure 5.19 Seal installation

2. A piston flush seal (part of a Piston Flush Seal Kit and normally used with buffers), may be located at the opposite end of the seal holder. If you use a piston flush seal it should be replaced once a year. The piston flush seal is not subject to the higher pressures seen by the piston seal, so maintenance of this part is only occasionally necessary.



The piston guide bushings do not need replacement. Retain them for new seal replacement.

To replace the piston flush seal:

- a. Use the seal removal tool to remove the piston flush seal.
 - b. Insert a new piston flush seal into the seal holder (spring side down). The piston flush seal is thicker than a piston seal. The seal holder's cavity on the piston flush seal side is deeper to accommodate the larger size.
 - c. Ensure that the piston flush seal is flush with the edge of the seal holder. Use the large end of the seal removal tool to push the seal into the holder.
3. Place the seal holder into the piston holder housing spring side up (Figure 5.20).

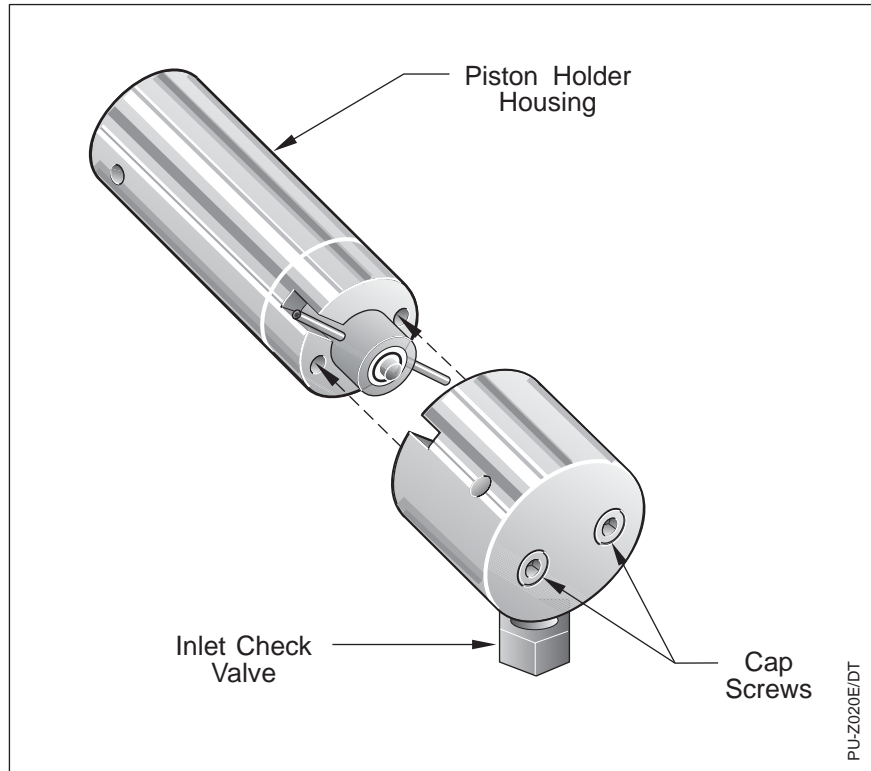


Figure 5.20 Seal holder alignment

4. If the Kel-F seal is being replaced, put the new seal in the pump head cavity now.
5. Install the pump head onto the housing using the two 9/64-inch Allen head screws.
 - a) For the inlet liquid end, the pump head must be connected to the piston holder housing as shown in Figure 5.21 (Inlet check valve down, retaining cap screw to the left).
 - b) For the outlet liquid end, the pump head must be oriented as shown in Figure 5.22.

Evenly tighten the screws to forty inch-pounds (tight).

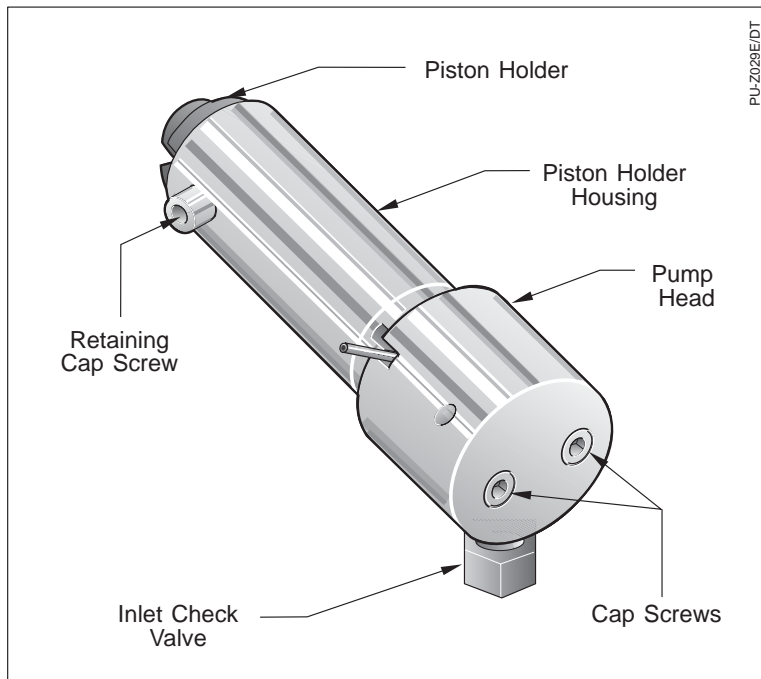


Figure 5.21 Installing the retaining cap screw (inlet liquid end)

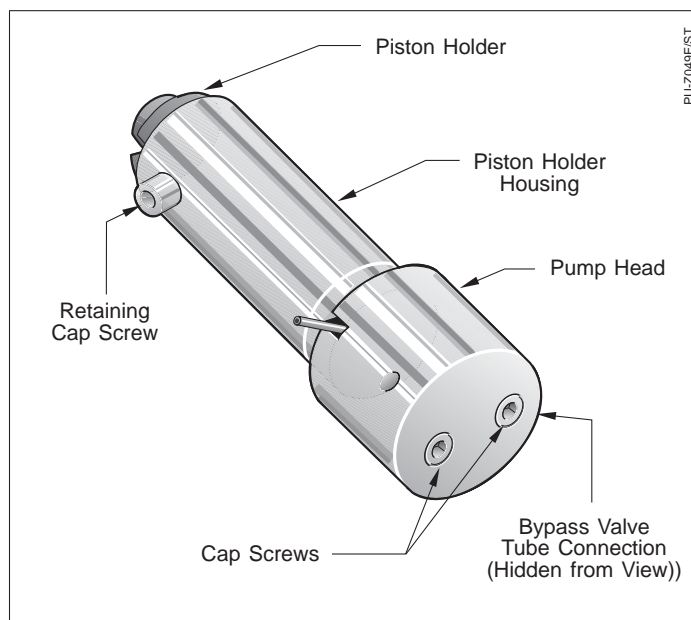


Figure 5.22 Installing the retaining cap screw (outlet liquid end)

6. Install the piston into the piston spring and then place them both into the piston holder housing (Figure 5.23). Do not press the piston through the seal at this time.
7. Compress the piston holder into the holder housing and install the retaining cap screw with its washer as shown in Figure 5.21 and Figure 5.22, so that the screw enters the slot in the piston holder. This action pushes the piston through the seal. Tighten the screw until snug.



NOTE: Make sure the retaining cap screw is oriented on the left-hand side of the piston holder housing for both the inlet and outlet liquid ends.

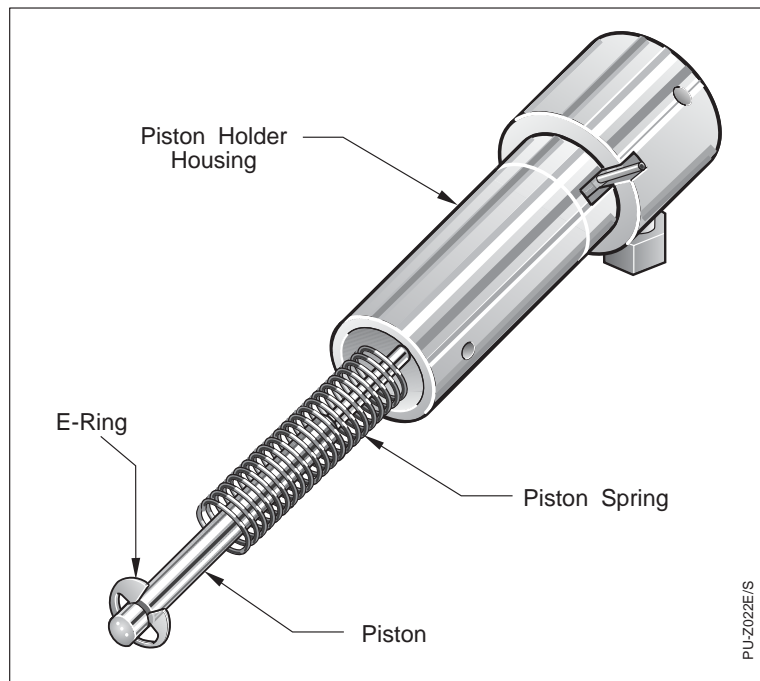


Figure 5.23 Piston installation

Liquid End Installation

To install the liquid end assemblies into the pump, the pump must be in the maintenance position. If the pump has not been switched off since the liquid ends were removed, the pump motor should still be in its maintenance position. If not, press [MENU], /TESTS/, /Maintenance Log/ then move the cursor to /Maintenance Position/ and press [ENTER]. The display shows:

```
To install or remove
liquid ends, press ENTER
```

Figure 5.24 Maintenance position message

Press [ENTER] to continue. The pump motor rotates for a few seconds and then is electrically locked into position. While the motor rotates the display shows:

Install or remove liquid ends when motor stops

Figure 5.25 Pump rotating cam to maintenance position

The pump is now in its maintenance position. The display will appear as shown in Figure 5.26. The liquid ends can be installed.

X-ducer	(date)	(due)	(vol)
· Maintenance Position			

Figure 5.26 The display after the motor moves cam to the maintenance position

1. Replace the inlet liquid end first. This liquid end contains tapped holes for the inlet check valve and the transducer tube. Install it by pressing in and turning it approximately 90 degrees counter-clockwise, until it locks into position. Be sure that the check valve (or the check valve hole, if the valve is not installed) is pointed down, and the transducer tube hole is pointed to the upper left-hand side (10 o'clock) (Figure 5.27).

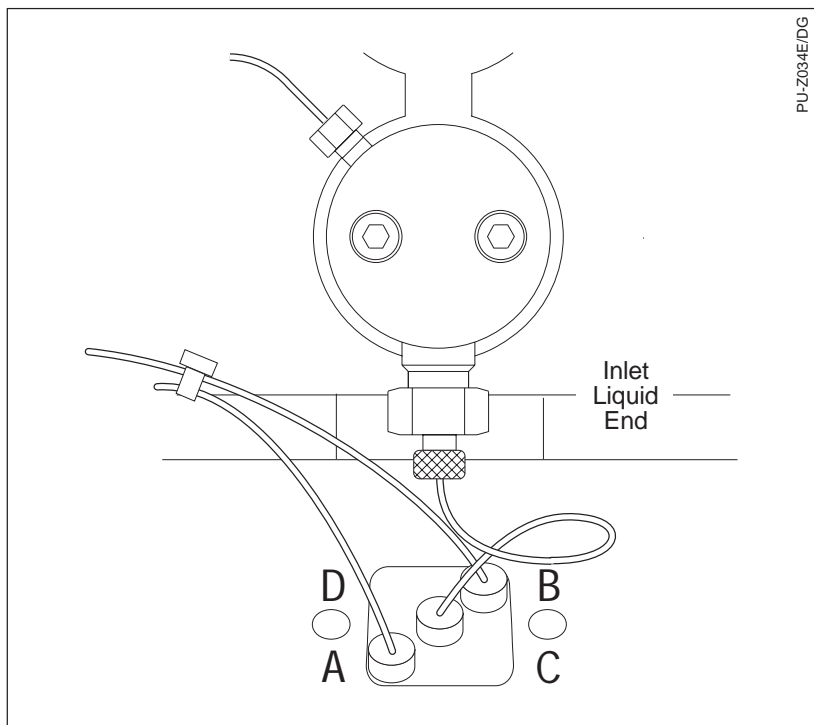


Figure 5.27 Inlet liquid end

2. Replace the outlet (upper) liquid end. This liquid end contains tapped holes for the crossover tube and the bypass valve tube. This liquid end is installed by pressing in and turning it approximately 90 degrees clockwise, until it locks into position. Be sure that the crossover tube hole is pointed up, and the bypass valve tube is pointed to the lower right-hand side (4 o'clock).
3. Replace the check valve and tubing. (Do not over-tighten fittings.) Generally, a 1/16-turn beyond finger-tight is sufficient to make a leak-free connection.



HINT: If the transducer check valve has been removed you can distinguish the two check valves: the inlet check valve has a wider fitting opening than the transducer check valve (connected to the pressure transducer).

4. After replacing the liquid ends, reset the VOL values in the Maintenance Log for all replaced components to zero (0).

POST-INSTALLATION SEAL CONDITIONING

Follow the procedure below each time you replace liquid end seals.

1. Open the column bypass valve and purge with methanol to clear air from the solvent lines and liquid ends.
2. Purge the pump through an old column or flow restrictor at 4000 psi for a minimum of 20 minutes. Reduce the flow to 1 mL/min and continue pumping for 15 minutes.
3. Check for solvent leaks. Do not return the pump to every-day service unless you are sure that no leaks are present.

INERT ASSEMBLIES

Inert assemblies commonly resemble stainless steel assemblies, except in the materials of which they are made. Maintaining an inert version of the SpectraSYSTEM or SpectraSERIES pump is similar to the descriptions in the first part of this chapter. However, the inert heads are larger, and do not contain the seal holder. Instead, the 30 mL/min kit contains a series of rings and seals that comprise the connection between the piston holder housing and pump head (Figure 5.28).

Maintenance Procedure

This section describes how to replace the 30 mL/min piston seals in an Inert/Biocompatible (30 mL) liquid end. It assumes that the entire liquid end has already been removed from the pump.



CAUTION! *Whenever working on an LC system wear eye and skin protection.*



NOTE: *Prevent contamination of pump parts! Wear finger protection and perform disassembly of pump parts on uncontaminated surfaces.*

1. Carefully remove the two cap screws from the pump head. Hold both the head and piston holder housing as you unscrew the screws.
2. Gently pull pump head and piston holder housing apart, watching carefully for any parts that may fall out.
3. Remove the three PEEK wash rings inside the pump head.
4. Using the seal removal tool, remove the colored piston seal inside the pump head. Rinse the seal and inspect it for contamination, damage, or wear.
5. Place the seal removal tool (notched end up) into the cleaned pump head. Slide a new piston seal onto the seal removal tool, with the O-ring side down.
6. Place the three PEEK wash rings on top of the piston seal.
7. The piston flush seal probably remained on the visible end of the piston, inside the piston holder housing. Remove the piston flush seal.
8. Insert a new piston flush seal onto the removal tool, on top of the PEEK wash rings, O-ring side down.
9. Gently press all seal components into place inside the pump head cavity.
10. Bring the piston holder housing and pump head together. Install the cap screws and tighten evenly and firmly. (Forty inch-pounds is recommended.)
11. Repeat steps 1 - 10 for the other liquid end.
12. Install the liquid ends back into the pump. A general procedure is found on page 108.

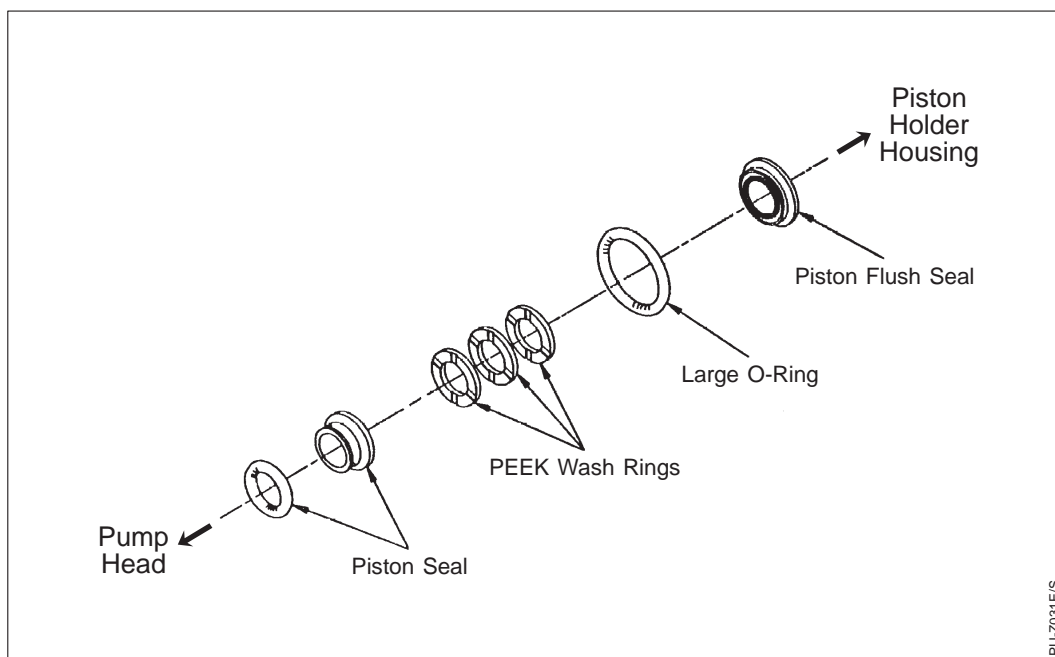


Figure 5.28 Contents of the 30 mL/min piston seal kit

CHECK VALVE MAINTENANCE

If the pump has notified you that it is time to replace check valves or if check valve replacement was recommended in Appendix A, *Troubleshooting*, then follow these steps. Check valve maintenance consists of:

- Inlet check valve removal and installation
- Transducer check valve removal and installation



NOTE: The factory-supplied replacement check valves are manufactured in a clean-room environment and capped to protect them from contamination. It is very important to maintain a clean environment when installing them.

Inlet Check Valve (bottom position)

To remove the existing inlet check valve and install a new one:

1. Remove the solvent inlet tube (Figure 5.27) from the check valve.
2. Remove the defective check valve by rotating the valve counter-clockwise with a 1/2-inch open-end wrench.
3. Install the new check valve by rotating clockwise until the valve is snug against the liquid end cylinder. Reconnect the inlet tubing. Tighten to finger-tight.

Transducer Check Valve

To remove the existing transducer check valve (connected to the Pressure Transducer) and install a new one:

1. Remove the transducer tubing from the transducer check valve and the inlet pump head (Figure 5.29).

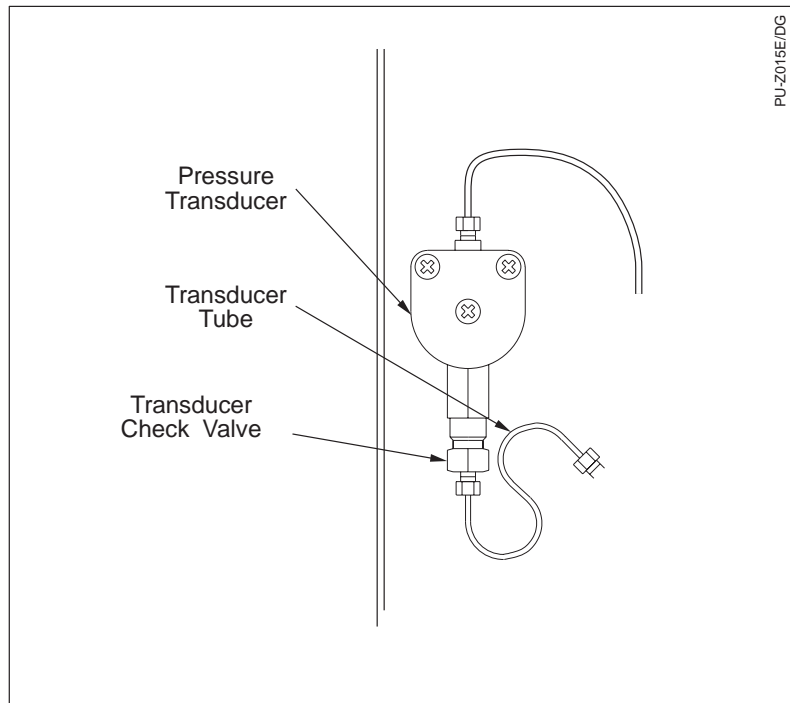


Figure 5.29 Transducer check valve

2. Remove the defective check valve by rotating it counter clockwise with a 1/2-inch open-end wrench.
3. Install the new check valve by rotating it clockwise until snug, and tighten with a 1/2-inch open-end wrench. Replace the connecting tubing. Tighten fittings only enough to stop leaks. Generally, this is 1/16-turn beyond finger-tight.

Maintenance Tips

This section contains useful maintenance tips for pump parts not directly related to solvent flow.

DRIP TRAY

A removable, white plastic solvent drip tray is located underneath the inlet bracket of your pump.

To remove the tray squeeze the top, front-edge of both sides of the tray together and carefully pull the tray out. You may need to wiggle the tray as you pull. If you see solvents in the tray, be particularly careful not to spill them as the tray is removed.



HINT: It may be easiest to use the index finger of each hand to push the sides together.

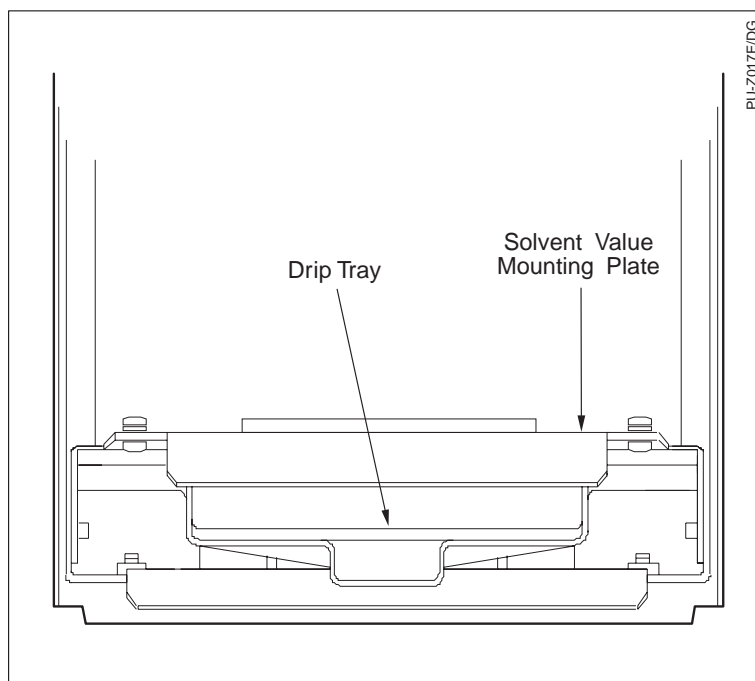


Figure 5.30 Drip tray installed

PASSIVATION OF STAINLESS STEEL COMPONENTS

All the major type 316 stainless steel components used in the SpectraSYSTEM pumps are passivated prior to assembly to ensure the removal of porous particles from the surface and to coat the surface with a layer of chromium oxide, which is highly resistant to

corrosion. All stainless steel replacement parts purchased from Thermo Electron are also passivated.

However, stainless steel components are subject to corrosion from strong acid solutions (in particular, materials containing halides), organic acids, and sometimes even water. Resistance to corrosion of the stainless steel components can be enhanced by using the following procedures.



CAUTION—Chemical Hazard! Take care when passivating with strong acids. Wear protective eye covering and protective clothing.



NOTE: Before installing any new parts not supplied from the Factory such as stainless steel tubing, the parts should first be passivated using the methods below.



NOTE: DO NOT expose a column to the passivation mixture. Remove the column before pumping if it is necessary to pump passivation solvents through the pump. It is preferable, however, to remove the components from the pump and then passivate them apart from the system.

1. When the surface area to be passivated is thoroughly clean, it is passivated by wetting the surface with a 20% nitric acid solution in deionized water for about 10 minutes at room temperature.
2. After passivation, thoroughly clean the parts to remove any residual nitric acid. Wash with deionized water until the system is neutral to pH paper. Follow up with another wash using 50-50 water/methanol followed by methanol. When thoroughly clean, blow dry using nitrogen. (Do not use the laboratory air system or air from a compressor that may contain an oily residue.)

If frequent passivation is required to protect your pump from aggressive solvent systems, you may wish to consider using the inert version of SpectraSYSTEM pumps. The inert pump parts do not require passivation.

Repair Instructions

If troubleshooting has pointed to a blown fuse in the power entry module, or to the need to replace the solvent switching valve (P1500 only), use the procedures below to make repairs.

POWER ENTRY MODULE FUSE REPLACEMENT

Instrument power is supplied by two 4.0-amp fuses housed in the fuse compartment of the power entry module, above the power cord receptacle.

To replace the fuses:

1. Ensure that the power cord is *not* connected to the pump.
2. Use a small, flat blade screwdriver to pry open the power selector/fuse cover. You will probably hear the top edge of the cover snap as it is pried open.
3. Pull out the fuse holder and discard the bad fuse. Place the new fuse into the holder with the metal end visible.
4. Snap the fuse holder back into place.



NOTE: If the power selector barrel accidentally comes out, be sure to replace it so that the correct voltage for your area shows through the voltage window.

5. Firmly snap the housing cover back in place. Be sure that the correct voltage is visible in the voltage window.



HINT: Use two thumbs to push up on the top half of the cover as you push in.

SOLVENT SWITCHING VALVE REPLACEMENT (P1500 ONLY)

To remove the solvent switching valve:

1. Turn off power.
2. Remove front cover.
3. Remove the solvent inlet tube fitting from the inlet check valve.
4. Loosen the two knurled screws on the front-left and front-right sides of the inlet bracket.
5. Lift and pull the bracket forward 3 - 4 inches.
6. Disconnect the inlet tubes from the solvent switching valves at locations A and B.
7. Remove the solvent inlet line from the center port of the valve.

8. Disconnect the solvent switching valve cable at the rear of the solvent valve cavity, and remove the solvent valve/bracket fully from the pump.

To install a new solvent switching valve:

1. Connect the replacement valve's cable to the connector at the rear of the solvent valve cavity.
2. Connect the solvent inlet line to the center port of the replacement valve. Tighten snugly but only finger-tight.
3. Re-connect the inlet tubes to the valve ports, making sure the identification of each inlet tube matches the identification of each valve port location.
4. Install the valve and bracket into the solvent valve cavity. Tighten the knurled screws.
5. Attach the solvent inlet line to the inlet check valve. Tighten snugly but only finger-tight.
6. Prime the pump using the technique described in Chapter 1.

A

Troubleshooting

Introduction

Your SpectraSYSTEM or SpectraSERIES pump is designed to operate trouble-free for many years when properly maintained. Most pump problems can be avoided by simple, periodic maintenance, as described in Chapter 5. However, in the event that an error message is displayed or if a mechanical or electrical failure is suspected, the problem can be easily diagnosed. Further, if the diagnosis indicates that a problem exists with non user-serviceable parts inside the pump, a qualified Thermo Electron service representative can quickly and easily replace most malfunctioning parts.

This appendix contains information on:

- Theory of operation
- General LC system troubleshooting
- Pump-specific hardware troubleshooting
- Error Messages
- Display Messages

A quick-reference hardware troubleshooting guide is included at the end of this appendix that includes tips for diagnosing and remedying hardware problems. This guide can save you time in diagnosing problems when the symptoms are known.

Theory of Operation

An isocratic pump works by first pulling a solvent into a valve. In the P1500 pump there are two valves; only one valve is used during operation, as specified in the run file. Solvent travels to the pump head, where a piston regulates the flow of the mixture to an outlet tube. The solvent is routed through the pressure transducer, into a second pump head, then through a bypass valve (closed during normal operation), and finally out to the LC system. The pump's outlet tubing is then generally connected to an automatic injector, such as an autosampler.

Troubleshooting Your Pump

SAFETY PRECAUTIONS

Observe the following safety precautions whenever troubleshooting hardware difficulties.



Caution!

A caution alerts you to situations that could result in personal injury. It also tells you how to avoid them.



High Voltage!

This icon alerts you to the presence of high voltage and to the potential injury that could occur from electrical shock were you to come in contact with a specific instrument area or component. It also tells you how to avoid contact with the high-voltage areas in your instrument.



Hot Surface!

This icon alerts you to potential injury that could occur from coming in contact with a heated surface or area on or in an instrument. It also tells you how to avoid contact with the heated surfaces in your instrument.

TROUBLESHOOTING TIPS

Eliminate all other possible sources of trouble

Before you spend any time trying to diagnose a suspected pump problem you should verify that the pump is the only source of difficulty. Systematically eliminate all other instruments in your LC system as the source of trouble. If you are not sure which component of your chromatography system is responsible for poor system performance the *General LC System Troubleshooting* section beginning on page 121 of this appendix provides useful suggestions.

When you're sure it's the pump

Once you have isolated the pump as the only remaining source of difficulty, a variety of self-tests are built into the pump to help you determine if your pump is operating correctly.

The next section describes the tests found in the /TESTS/ menu item. Instructions for the built-in hardware and electronics diagnostics are contained within the description of the Test Menu.

Table A.1 General Troubleshooting Table

<u>Symptom</u>	<u>Cause/Remedy</u>
1. No flow.	a) Check mobile phase connections, b) Check for leaks, c) Check pump troubleshooting guide.
2. High back pressure.	a) Check flow rate and system/column specifications, b) Check for tubing or column blockage, c) Check pump troubleshooting guide.
3. Unstable baseline or drift.	a) System/column not equilibrated; allow more time, b) Check detector troubleshooting guide, c) Check pump troubleshooting guide.
4. Baseline noise.	a) Check for air bubbles in system, degas solvents, b) Check for system/solvent contamination, c) Check pump troubleshooting guide, d) Check PC1000 troubleshooting guides.
5. No peaks.	a) Check detector and data system connections, b) Check autosampler troubleshooting guide, c) Check sample retention with chromatographic conditions.
6. Contaminating/ghost peaks.	a) Clean system and column, b) Check autosampler troubleshooting guide, c) Check pump troubleshooting guide.
7. Poor peak shape.	a) Check system for leaks, b) Check fittings and tubing lengths, c) Check column performance, d) Check autosampler troubleshooting guide, e) Check pump troubleshooting guide, f) Check detector troubleshooting guide.

Table A.1 General Troubleshooting Table, *continued*

<u>Symptom</u>	<u>Cause/Remedy</u>
8. Poor retention time reproducibility.	a) Check system for leaks and bubbles, b) System/column not equilibrated, allow more time, c) Check column performance, d) Check pump troubleshooting guide, e) Check autosampler troubleshooting guide, f) Check ISM or data system troubleshooting guide.
9. Poor peak area reproducibility.	a) Check column performance, b) Check autosampler troubleshooting guide, c) Check data system troubleshooting guide.
10. Non-integrated or too many peaks.	a) Check integrator or data system troubleshooting guide.
11. No instrument or device control.	a) Check cable connections, b) Check system configuration, c) Check individual instrument troubleshooting guide, d) Check integrator or data system troubleshooting guide.

For more detailed chromatographic troubleshooting, refer to any HPLC troubleshooting reference book or call your local sales or service representative.

Table A.2 Pump-specific Hardware Problems

<u>Symptom</u>	<u>Possible Cause</u>	<u>Diagnostic/Remedy</u>
1. No response when power is switched on.	a) Power cord not firmly installed.	a) Re-seat cord.
	b) Power cord defective.	b) None. Replace cord.
	c) Power entry module fuse blown.	c) None. Refer to page 116 for fuse replacement.
2. No display. Fan and pump run OK.	a) Display contrast needs adjustment.	a) Press [STATUS]. Press and hold the right-arrow key. Press the [+] or [-] key to adjust the display contrast. Press [STATUS] again.
	b) Internal fuse blown.	b) None. Contact Thermo Electron representative for service.
3. No display.	a) System PCB defective.	a) None. Contact Thermo Electron representative for service.
4. Only fan runs with power on.	a) Internal fuse blown.	a) None. Contact Thermo Electron representative for service.
	b) Display cable loose/unplugged.	b) None. Contact Thermo Electron representative for service.
5. No response to keypad entry. Display OK.	a) Keypad defective or System PCB defective.	a) None. Contact Thermo Electron representative for service.
6. Random display.	a) Display defective.	a) Run Display Test page 81. Contact Thermo Electron representative for service.
7. Pump motor will not run.	a) Max pressure set to zero.	a) Press [STATUS]. Set Maximum Pressure to a value > 100 psi.
	b) Motor defective.	b) Run Hardware Series Test page 82. Contact Thermo Electron representative for service.
	c) Motor cable unplugged.	c) Hardware Series Test page 82. Contact Thermo Electron representative for service.
	d) Drive circuit.	d) Hardware Series Test page 82. Contact Thermo Electron representative for service.

Table A.2 Pump-specific Hardware Problems, *continued*

<u>Symptom</u>	<u>Possible Cause</u>	<u>Diagnostic/Remedy</u>
	e) Internal fuse blown.	e) Hardware Series Test page 82. Contact Thermo Electron representative for service.
	f) Target pressure low.	f) None. Press [PURGE] and then reinitialize file.
8. Oil found on inlet bracket.	a) Main bearing over-lubricated.	a) None. Small amount of oil is normal.
9. Solvent not switching.	a) Switching valve cable loose.	a) Hardware Series Test page 82. Reconnect cable.
	b) Switching valve defective.	b) Hardware Series Test page 82. Replace solvent switching valve.
	c) Switching valve drive defective.	c) Hardware Series Test page 82. Contact Thermo Electron representative for service.
	d) Cam marker failure.	d) Hardware Series Test page 82. Contact Thermo Electron representative for service.
10. Switching valve does not click open.	a) Internal fuse defective.	a) Hardware Series Test page 82. Contact Thermo Electron representative for service.
	b) Switching valve drive failure.	b) Hardware Series Test page 82. Contact Thermo Electron representative for service.
11. Flow unstable (will not go READY).	a) Check valve failure.	a) Flow Stability Test page 72. Replace Check Valve Test page 74. Replace check valve Appendix A, page 112.
	b) Immiscible solvents.	b) Flow Stability Test page 72. Run Check Valve Test page 74. Change solvent system.
	c) Unstable load (column).	c) Flow Stability Test page 72. Check Valve Test page 74. Pump must see stable, non-compressible load.
	d) Insufficient degas.	d) Flow Stability Test page 72. Check Valve Test page 74. Increase helium rate (if helium degas) or decrease flow rate (if vacuum degas). Use vent line and good bottle cap seal.

Table A.2 Pump-specific Hardware Problems, *continued*

<u>Symptom</u>	<u>Possible Cause</u>	<u>Diagnostic/Remedy</u>
	e) Circuitry failure.	e) Hardware series Test page 82. Contact Thermo Electron representative for service.
	f) Partially clogged frit or filter on high pressure side of pump.	f) Hardware Series Test page 82. Replace filter or frit.
12. Sudden shift in pressure display with no flow.	a) Pressure transducer failure.	a) None. Contact Thermo Electron representative for service.
	b) Circuitry failure.	b) Hardware Series Test page 82. Contact Thermo Electron representative for service.
13. Pump goes from RUN immediately to READY (will not maintain RUN state).	a) Run file has only one time line.	a) View run file. Add time line and reload file.
14. Pump will not start or stop remotely.	a) Incorrect wiring.	a) External Inputs Test page 81. Correct wiring.

Table A.3 Error Messages

BELOW MINIMUM PRESSURE ;	The column pressure has fallen below the file's Minimum Pressure setting. Check for mobile phase leaks.
CHECKSUM ERROR BAD PROGRAM ;	The program memory may have been corrupted. Make a note of the circumstances which preceded the message and contact Thermo Electron.
CODE ERROR PROGRAM LOST ;	The program code has errors. Make a note of the software version and the circumstances which preceded the message. Contact Thermo Electron.
CODE ERROR STACK UNDERFLOW ;	The program code has errors. Make a note of the software version and the circumstances which preceded the message. Contact Thermo Electron.
CODE ERROR STACK OVERFLOW ;	The program code has errors. Make a note of the software version and the circumstances which preceded the message. Contact Thermo Electron.
CODE ERROR FALSE POWER FAIL ;	You may have experienced low line voltage ("brown-out") or there may be hardware problems. Note the circumstances which preceded the message and contact Thermo Electron.
EXCEEDS FLOW RANGE	A flow rate was entered in the pump file which exceeded the flow rate capabilities of the pump. The maximum flow rate for standard SpectraSYSTEM pumps is 10 mL/min. If higher flow rates are needed, inert/biocompatible liquid ends are available to increase the flow rate to 30 mL/min. Contact your local sales representative for information.
MAX PRESSURE EXCEEDED ;	The column pressure of the system has exceeded the MaxP (maximum pressure) value entered into the pump file. The file's Maximum Pressure value may need to be increased. The default value is 3000 psi for 10 mL/min liquid ends (the maximum is 6000 psi). If your operating column pressure is increasing, check for column plugging.
MOTOR STALLED	The motor is unable to maintain the combination of requested flow rate and needed pressure for operation. Reduce flow rate or check for flow restriction or plugged column frit.
OVER MAXIMUM TEMPERATURE ;	The pump has overheated. This may be due to blocked ventilation slots or to a hardware malfunction.
POWER FAILURE CONTINUE ;	A power failure has occurred or the pump was switched off with the motor running. The pump has automatically resumed operation. ("Continue" was selected in /OPTIONS/, /Error Recovery/, AC Power Fail.)
POWER FAILURE STOP ;	A power failure has occurred or the pump was switched off with the motor running. The pump has automatically stopped. ("Stop" was selected in /OPTIONS/, /Error Recovery/, AC Power Fail.)
POWER FAILURE SHUTDOWN ;	A power failure has occurred or the pump was switched off with the motor running. The pump has automatically loaded and run the shutdown file. ("Shutdown" was selected in /OPTIONS/, /Error Recovery/, AC Power fail.)
ZERO FLOW RATE	A time line (other than Time = 0.0 min) with a zero flow rate was encountered. To remedy, enter a valid flow rate in the first line of the pump file. Rates between 0.01 and 10 mL/min are valid for standard SpectraSYSTEM and SpectraSERIES Pumps. The optional inert/biocompatible liquid ends extend the maximum flow rate to 30 mL/min.

Table A.4 Display Messages

Maintenance Due See Log	A volume milestone has been reached. Consult the Maintenance Log for component by pressing the [MENU] key and selecting /TESTS/, /Maintenance Log/. For more information, refer to Chapter 5.
Memory Full File Not Copied	There is not enough memory available to copy the parameters of one file into another. Free memory by deleting an old or unused file, or by reducing the number of time lines in a file. Try to copy the file again.
Memory Nearly Full Data May Not Be Saved	There may not be enough memory available. Double-check the file to ensure that no parameters or settings were lost. Free memory by deleting an old or unused file, or by reducing the number of time lines in a file. Try to save the file again.
No Queue Available	You cannot load a queue if one has been set up.
Not Enough Room File Not Saved	The run file changes cannot be saved to the file. Free memory by deleting an old or unused file, or by reducing the number of time lines in a file. Try to save the run file once more from the Status Menu.
Protected File Cannot Be Copied To	You cannot modify a protected file.
Protected File Cannot Be Deleted	You cannot modify a protected file.
Protected File Cannot Be Edited	You cannot modify a protected file.
Queue Loaded Cannot Load File	When a queue is loaded you cannot load any other file without first pausing the queue.
Run In Progress No Testing Allowed	The test cannot be initiated because the pump is in RUN or is in HOLD.

Table A.5 Solvent Compatibility for Pump Wetted Surfaces

Reagents	Stainless Steel (316)	Polyetheretherketone (PEEK)	Piston Seal Gold	Piston Seal Black	PTFE	Check Valve Ceramic
Acids						
Acetic, 10%	Excellent	Excellent	Excellent	Limited	Excellent	Excellent
Acetic, 50%	Limited	Excellent	Excellent	Limited	Excellent	Excellent
Hydrochloric, 10%	Unsatisfactory	Excellent	Excellent	Limited	Excellent	Limited
Hydrochloric, 50%	Unsatisfactory	Excellent	Excellent	Limited	Excellent	Limited
Nitric, 10%	Excellent	Excellent	Excellent	Limited	Excellent	Excellent
Nitric, 50%	Limited	Excellent	Limited	Limited	Excellent	Excellent
Phosphoric, 10%	Excellent	Excellent	Limited	Limited	Excellent	Excellent
Phosphoric, 50%	Limited	Excellent	Limited	Limited	Excellent	Excellent
Sulfuric, 10%	Limited	Excellent	Excellent	Limited	Excellent	Excellent
Sulfuric, 50%	Unsatisfactory	Excellent	Excellent	Limited	Excellent	Excellent
Water, 100%	Excellent	Excellent	Excellent	Unsatisfactory	Excellent	Excellent
Bases						
Ammonium Hydroxide, 10%	Excellent	Excellent	Excellent	Limited	Excellent	Excellent
Sodium Hydroxide, 10%	Limited	Excellent	Excellent	Limited	Excellent	Excellent
Sodium Hydroxide, 50%	Unsatisfactory	Excellent	Excellent	Limited	Excellent	Excellent
Organics						
Acetone, 100%	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Acetonitrile, 100%	Excellent	Unsatisfactory	Unsatisfactory	Excellent	Excellent	Excellent
Chloroform, 100%	Excellent	Unsatisfactory	Unsatisfactory	Unsatisfactory	Limited	Excellent
Dimethyl Sulfoxide, 10%	Excellent	Limited	Limited	Limited	Excellent	Excellent
Dimethyl Sulfoxide, 80%	Excellent	Unsatisfactory	Unsatisfactory	Unsatisfactory	No Data	No Data
Isopropanol, 100%	Excellent	Limited	Excellent	Excellent	Excellent	Excellent
Methanol, 100%	Excellent	Limited	Excellent	Excellent	Excellent	Excellent
Methylene Chloride, 100%	Excellent	Unsatisfactory	Unsatisfactory	No Data	Excellent	Excellent
Tetrahydrofuran, 10%	Excellent	Limited	Unsatisfactory	No Data	Excellent	Excellent
Tetrahydrofuran, 80%	Excellent	Limited	Excellent	Excellent	Excellent	Excellent
Toluene, 100%	Excellent	Unsatisfactory	Limited	Limited	Excellent	Excellent
Urea, 100%	Excellent	Unsatisfactory	Unsatisfactory	No Data	Limited	Excellent
	Excellent	Excellent	Excellent	No Data	Excellent	Limited

Excellent = Standard or better lifetime with no appreciable chemical attack

Limited = Variable lifetime given actual mobile phase composition, pressure, and temperature

Unsatisfactory = Significant chemical attack and decrease in lifetime

B

Glossary

A

autosampler an instrument designed to automatically inject samples into the sample flow path with a high degree of precision and reproducibility; sometimes called an injector

B

baseline the reference line at the bottom of a chromatogram from which measurements are made; a baseline represents the chromatogram that would be drawn if only the mobile phase (with no sample) were run through the column

binary capable of mixing or switching between two solvents

biocompatible describes components that are inert when used with biological samples; biocompatible components are usually made from titanium, Teflon®, PEEK, quartz, or sapphire

buffer a medium that resists changes in acidity and alkalinity

C

channel the path along which something (solvent or information) flows

chromatogram a plot depicting the separated components in a sample (absorbance units versus time); each component is shown as a separate peak whose concentration can be determined by studying the area under the peak

chromatograph the basic set of instruments needed to perform chromatography: a pump, injector (manual or automatic), a column, and a detector; various recording and data handling instruments are common additions

chromatography a means of separating and analyzing mixtures of chemical substances

column the packed tube through which a sample is passed for separation; the sample separates according to the way in which it adheres to the column's packing material

component an "ingredient" in a chemical mixture, also the individual parts of a liquid end assembly

conditioning the process of preparing the surface of the column wall and introducing the buffer pH conditions into the column before a run

configuration the way instruments are interconnected to form a system

cursor a moving or blinking symbol on the display which indicates where information is entered

D

default a value or choice built into a system; if no specific choice is made, instruments will run (or data analyzed) using the default settings

degassing removal of dissolved gas (*i.e.*, oxygen) from the solvent to prevent bubbles from forming in the pump; degassing can be done by vacuum or by sparging

detector the instrument used to detect the presence of a chemical compound

diagnostics ways of detecting and isolating instrument or software problems

digit an editable space within a field

display the backlit LCD screen on all SpectraSYSTEM instruments

E

elution time the length of time needed to pass a particular sample through a packed LC column

equilibration the process used to bring a system (solvent, column, etc.) to a point of equilibrium, where all thermal and chemical reactions occur at equal rates; a stable baseline is a good sign of a well-equilibrated system

error message a printed or displayed message that notifies the user of an error condition

error recovery user-selectable responses to error conditions detected by the instrument, such as a power interruption or over-pressure

external event an action performed by an external device that is under the control of the current instrument (see also timed event)

F

field an area in a display, screen, or menu where an entry is required or a choice must be made

file protect a P1500 setting which allows files to be edited when "off" and protects files from being changed by editing when "on"

flow parameters flow rate, solvent, and run time

flow rate the rate at which solvent flows through a system

G

ground terminal a terminal used to connect the ground or earth lead of a signal or contact closure cable; generally green and/or black

H

helium manifold a pneumatic assembly containing valves and switches for regulating helium sparging

helium sparging see sparging

I

inert see biocompatible

injection the manual or automatic introduction of a sample into a chromatography system

integrator the instrument used to analyze data and produce a chromatogram

isocratic constant solvent composition

K

Kel-F seal the translucent seal, made of Kel-F material, inside the pump head which faces the piston seal

keypad all of the keys by which you can communicate with an instrument or computer

L

LC Liquid Chromatography

linear a gradient curve that follows a straight line

liquid end the inlet or outlet assemblies of the pump consisting of the head, piston, seals, and sometimes a check valve

M

maintenance log	a place to record dates, service, and cumulative solvent volume pumped
menu	a list of choices
method	the set of parameters that define how one or more analyses will be accomplished
method development	the process of specifying the parameters under which an instrument will perform a particular function

N

NOVRAM	Non-volatile RAM (random access memory). Computer memory into which the user can enter information and instructions and from which the user can recall information. Data in NOVRAM are saved even when the instrument is switched off.
---------------	--

P

parameter	a value or set of values used to define the characteristics or behavior of an instrument or system
PEEK	polyetheretherketone; a material frequently used in fabricating inert/biocompatible components
piston	the short cylinder piece that moves inside the sealed cylindrical opening and is used to pressurize fluid
piston holder housing	the shaft into which the piston and its holder are housed
piston flush seal	the low-pressure spring seal inside the liquid ends, facing the piston assembly
piston seal	also called pump seal, a high-pressure spring seal located inside the pump head
plot	the presentation of analytical data in a graphical manner; typical plots include chromatogram traces and calibration curves
prime	to flush the solvents contained in a new pump in order to prepare the pump for solvents chosen by the user
pump	the instrument used to push a liquid solvent through a chromatography system
purge	to flush the system with fresh, degassed solvent

Q

queue a set of files in a prearranged order

R

RAM Random Access Memory (computer)

real-time the current, actual time

reproducibility the precision with which a piece of data can be repeated; a good measure of a system's overall performance

retaining screw also retaining cap screw; the screw which holds the piston assembly into the piston holder housing

run a complete analytical operation cycle of the chromatographic system

run file the file that has been loaded and that the pump is currently operating by

run time the duration of a sample run, from injection to separation

S

sample a known or unknown substance in a small quantity

seal holder a metal part used for pumps fitted with standard parts which contains two seals, (piston seal and piston flush seal) and allows the pump head and piston holder housing to be joined

shutdown file a special file used by the pump after the pump has been in a READY state for a period of time set by the user

solvent a substance that can completely dissolve another; the mobile phase of an LC system

solvent filter a small cylindrical attachment for inlet tubing used to filter a solvent prior to the solvent entering a pump

solvent program a set of time lines indicating a time, selected solvent, and flow rate

sparging a degassing technique in which solvent gases are replaced with an inert gas such as helium or nitrogen

status the current condition

status lock a feature used to prevent a run file from being changed from the Status Menu

stroke one complete revolution of the pump's cam which displaces both pistons

system a set of chromatography instruments that operate together in a concerted manner to produce an analytical result

T

timed event an instrument action triggered to occur at a specific, preset time during a run or analysis

trace a chromatogram

transducer check valve the valve which attached to the inlet of the pressure transducer

V

vacuum degassing the technique of removing dissolved gasses from solvents by passing the solvent through tubing made of gas-permeable membrane, and creating a vacuum around the tubing, thus allowing gasses to be evacuated out of the solvent and into the surrounding chamber

viscosity the degree to which a fluid resists flow

C

Kits and Parts Lists

Introduction

This chapter contains unpacking lists and information for several kits and accessories available from Thermo Electron for use with your SpectraSYSTEM pump. Described in this chapter are:

- Accessory Kit p/n A4070-010
- Standard Maintenance Kit p/n A4050-010
- Inert/Biocompatible Maintenance Kit p/n A4060-010
- Standard LC Fittings Kit p/n A4051-010
- Inert/Biocompatible LC Fittings Kit p/n A4061-010
- Piston Flush Seal Kit (10 mL) p/n A4114-010
- Piston Seal Kit (30 mL) p/n A4084-010
- Solvent Inlet Tube Kit p/n A4074-010
- Solvent Tube Extension Kit p/n A4117-010
- Manual Injection Valve Bracket Kit p/n A4054-010
(also included with A4052-010, the Rheodyne 7125 Standard Bracket Kit, and A4053-010, the Rheodyne 9125 Inert/Biocompatible Bracket Kit, both of which include an injection valve)
- Narrow-bore Upgrade Kit p/n A5190-060

Accessory Kit

Your kit consists of:

- 2 4 amp, 250V fuse
- 1 12-inch piece stainless steel tubing
(0.06 OD x 0.02 ID) (27.5 cm length)
- 2 nuts, 0.06 OD
- 2 ferrules
- 1 seal removal tool
- 2 piston seals
- 1 hex/ball wrench
- 1 4-connection cable
- 1 external function connector
- 1 20 mL (cc) priming syringe with Luer LOK® tip
- 1 Luer adapter
- 1 waste tube kit:
- 1 48-inch Teflon tubing, 0.031 ID (123 cm)
- 1 washer and finger-tight fitting
- 1 solvent bottle label
- 3 stainless steel tubing, 0.06 OD x 0.007 ID

Standard Maintenance Kit

The Standard Maintenance Kit contains the following:

- 4 inlet filter cartridges
- 1 inlet check valve
- 1 transducer check valve
- 2 sapphire pistons (0.125 inch-diameter)
- 1 barbed fitting (nylon)
- 1 piece piston flush tube (Tygon®), 0.0655 ID (approx. 76 cm long)
- 1 syringe (20 cc)
- 6 piston seals
- 2 piston flush seals
- 6 Kel-F seals
- 1 seal removal tool
- 1 seal insertion tool

The 10 mL/min Inert/Biocompatible Maintenance Kit (p/n A3982-010) contains the same items as the Standard Kit, but made from inert materials as appropriate.

Inert/Biocompatible Maintenance Kit

The 30 mL/min Inert/Biocompatible Maintenance Kit consists of:

- 1 barbed fitting (nylon)
- 4 inlet filter cartridges (Teflon)
- 1 inert inlet check valve
- 1 inert transducer check valve
- 2 sapphire pistons (0.218-inch diameter)
- 1 piston flush tube (Tygon)
- 1 syringe (20 cc) with Luer LOK tip
- 2 30 mL/min piston seal kits (described below)
- 1 seal removal tool

The 10 mL/min Inert/Biocompatible Maintenance Kit (p/n A3982-010) contains the same items as the Standard Maintenance Kit (page 136), except that some items are made from inert materials.

Standard LC Fittings Kit

Your kit consists of:

- 1 storage/carrying case
- 1 120-inch piece Teflon tubing, 0.063-inch ID
- 2 adapter fittings (10-32M)
- 4 Rheodyne nuts/ferrules
- 4 Parker type nuts/ferrules
- 3 wrenches (sizes: 1/4" - 5/16", 3/8" - 7/16", 1/2" - 9/16")
- 1 1/8-inch tube adapter for gas regulator assorted tubing:
 - stainless steel 0.020-inch ID
 - stainless steel 0.010-inch ID

Fittings kits contain tubing and fittings commonly needed for LC systems. These fittings can be used for several different instruments. If you change your LC configuration or damage connections, the fittings provided in this kit should allow you to make changes or replacements quickly and easily. All fittings can be kept in the compartmentalized storage box.

Inert/Biocompatible LC Fittings Kit

Your kit consists of:

- 1 storage/carrying case
- 1 120-inch piece Teflon tubing (0.063-inch ID)
- 6 finger-tight nuts/ferrules, PEEK
- 2 nuts/ferrules; steel nut, PEEK ferrule, high pressure
- 1 1/8-inch tube adapter for gas regulator
- 1 PEEK tubing, 0.020ID x 60-inch (152 cm length)
- 1 PEEK tubing, 0.010ID x 60-inch (152 cm length)
- 3 wrenches (sizes: 1/4" - 5/16", 3/8" - 7/16", 1/2" - 9/16")
- 1 tubing cutter
- 3 PEEK tubing, 0.010ID x 4-inch (10 cm length)
- 1 PEEK tube, 0.010ID x 24-inch (61 cm length)

Piston Flush Seal Kit (10 mL)

Your kit consists of:

- 1 piece tubing, 30-inch, Tygon (76 cm length)
- 1 barbed fitting (nylon)
- 2 piston flush seals
- 1 seal removal tool
- 1 seal insertion tool
- 1 syringe, 20 cc

Piston Seal Kit (30 mL)

Your kit consists of:

- 1 piston (with small O-ring, high pressure)
- 3 PEEK wash rings
- 1 large O-ring
- 1 Piston flush seal (low-pressure)

Solvent Inlet Tube Kit

Your kit consists of:

- 1 bottle cap
- 1 tubing, Teflon, 0.063 ID

Solvent Tube Extension Kit

Your kit consists of:

- 4 60-inch extension tubing, with washer and union (152 cm length)
- 1 tubing Teflon, 0.063 ID

Manual Injection Valve Bracket Kit

Your kit contains:

- 1 11-3/16 inch steel mounting rod
- 2 rod brackets
- 2 short column brackets
- 2 long column brackets
- 1 manual injector valve mount
- 4 short set screws (6-32 x 1/4-inch)
- 2 flat-head screws (8-32 x 3/8-inch)
- 2 screws (6-32 x 7/16-inch)
- 2 long set screws (6-32 x 5/8-inch)
- 1 Allen wrench (1/16-inch)
- 1 12 inches stainless steel tubing, 0.06 OD x 0.01 ID, 12 inches

If you purchased a Rheodyne valve (standard or inert/biocompatible), you also received the valve, accompanied by Rheodyne's documentation.

Installing the Holder onto the Valve

To install the valve onto the bracket, do the following:

1. Move the injector valve handle to the "LOAD" position. Using the Allen wrench supplied with your Rheodyne valve, loosen the two set screws and remove the injection valve handle.
2. Hold the valve mounting bracket so that the two set screw holes are on the left. Place the injector valve into the bracket from the rear. If your injector valve has a remote start cable attached to it, place the cable into the cut-out on the left side of the bracket. When aligned correctly the "V" made by the two flats of the valve shaft will point to the upper left-hand mounting hole.
3. Fasten the valve securely with the two flat-head (Phillips) screws.
4. Attach the handle to the valve by tightening the two set screws, making sure that each screw is positioned over a flat edge of the valve shaft.
5. Install a long (5/8-inch) set screw into each of the valve bracket's mounting holes.
6. Install the rod through the valve bracket so that the notched portion of the rod faces you, as you look at the front of the injection valve.

7. Slide the valve bracket so that it is within the top quarter of the rod. Tighten the two set screws, securing the valve bracket to the rod.
8. Brackets for long (22 cm - 25 cm) and short (3 cm - 10 cm) columns are provided. Choose the bracket size that matches the type of column you use. Both brackets can be mounted, if desired.
9. Install a short (1/4-inch) set screw into each column bracket you wish to use. Slide the brackets onto the rod for positioning. Temporarily tighten the set screws to hold the brackets in place (Figure C.1).
10. Remove the two top cover screws from the right side of your SpectraSYSTEM pump or detector. Install a rod bracket into the lower hole, using a 7/16-inch Phillips-head screw.
11. Rest the rod in the lower rod bracket (with the injector valve facing toward the front) and place the upper rod bracket on top of the rod. Attach the upper rod bracket to the pump or detector, using the other 7/16-inch screw.
12. Re-position the column brackets or manual injector valve as needed, and tighten the set screws.

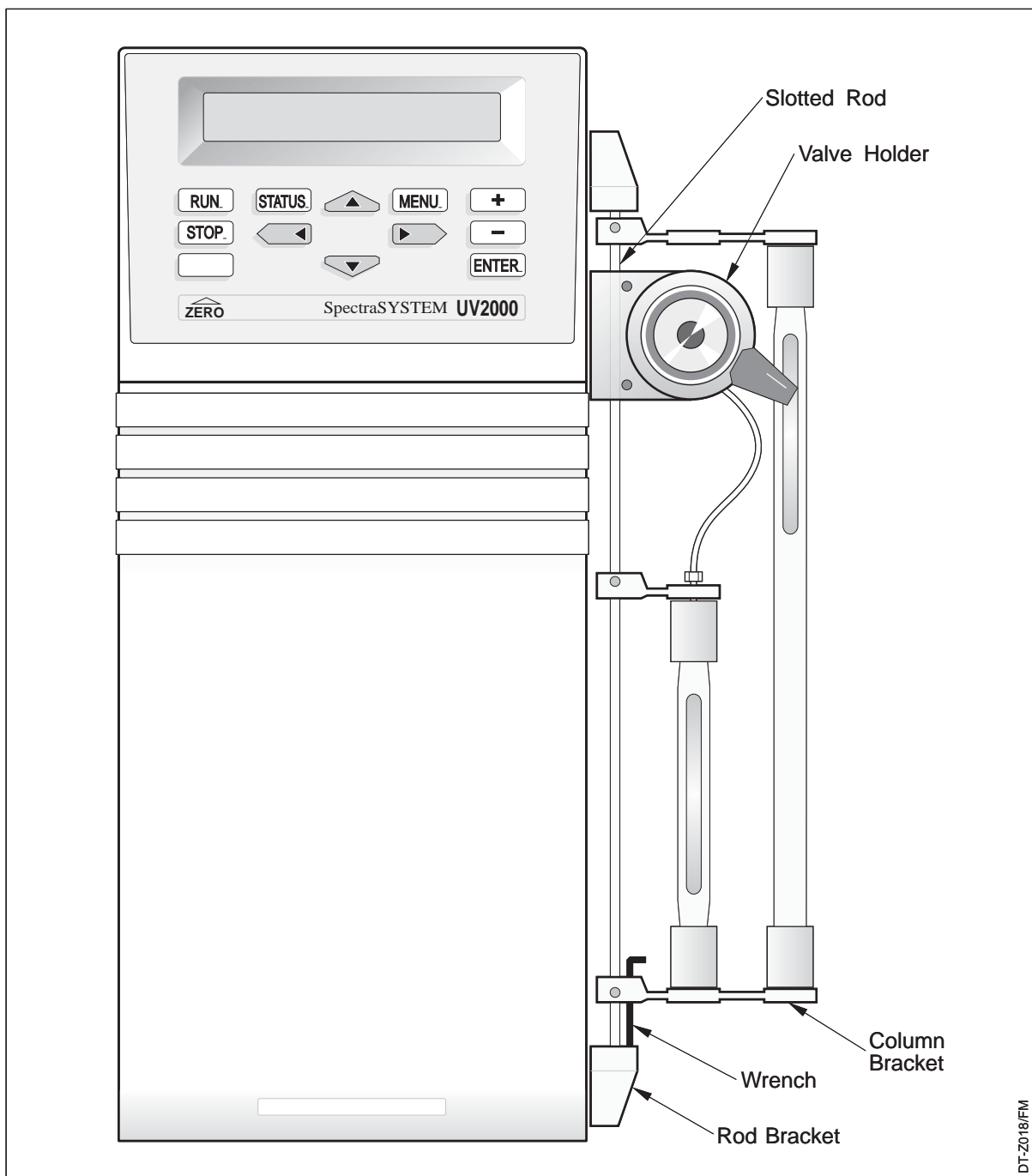


Figure C.1 Manual Injection Valve/Column Bracket mounted to a SpectraSYSTEM instrument

Narrow-bore Upgrade Kit

Your kit consists of:

- 0.01” ID bypass, crossover, and transducer stainless steel tubes
- 0.03” ID Teflon solvent inlet tube
- Low-volume outlet liquid-end assembly
- 3 µL static mixer
- 0.007” stainless steel tubing
- Nuts and ferrules for all tubes
- Instruction sheet

KEYS

[+] and [-] keys, 24, 27
 [ENTER] key, 26
 [PURGE] key, 26
 [RUN] key, 25, 49
 [STOP] key, 26, 50
 [^] key, 26

A

AC Power Fail, 60
 accessories, 135
 Accessory Kit, basic, 3, 135
 active tests, 70
 alphanumeric entries, 27
 increasing and decreasing, 24
 arrow keys
 illustrated, 25
 rules, 23
 asterisks, 28

B

BELOW MINIMUM, 126
 binary switching valve, see switching valve:, 116
 blank key, see PURGE key, 26
 Bypass valve, 12
 illustrated, 13

C

Calibration Menu, 75
 illustration, 75
 caution, defined, xx, 95, 120
 cautions
 maintenance, 95
 troubleshooting, 120
 Check Valve test, 73
 results, 74
 check valves
 inlet, illustration, 99
 inlet, maintenance, 112
 maintenance, 112
 transducer, illustration, 113
 transducer, maintenance, 113
 Checklist, 23
 CHECKSUM ERROR, 126
 CODE ERROR, 126
 column holder, see kits, manual injection valve bracket,
 139

Commands
 Continue, 52
 Copy, 38, 45
 Delete (FILE(S)), 38, 46
 Delete (QUEUE), 65
 display, 51
 Hold, 50, 52
 Load (FILE(S)), 45
 Load (QUEUE), 65
 Menu, 27, 51
 Pause, 66, 68
 Reset, 50, 51
 Software Version, 71

Commands
 Confirmation messages, 28
 Continue, 52
 conventions
 brackets, xix
 capitalization, xix
 slashes, xix
 conventions used in manual
 caution, xx, 95, 120
 hint, xx
 icons, xx
 note, xx
 standard words, xx
 text, xix
 two-line display, xix
 conventions:, xix
 Copy (FILES), 38
 Current History, 79
 cursor
 movement, 24
 square, 24
 underscore, 24
 Cursor Speed, 62
 Cycle Step Count test, 80

D

damage
 shipping, 3
 Degassing, 10
 Delete (FILE(S)), 46
 Delete (FILE), 38
 Delete (FILES), 38
 Delete (QUEUE), 65
 Diagnostics Menu
 illustration, 72
 display
 contrast adjustment, 123
 Display test, 81
 down-arrow (t), right side of display, 24
 drip tray, 114

E

Edit Menu (FILE), 38
Edit Menu (FILES), 39
Edit Menu (QUEUE), 64
Editing parameters during a run, 53
eluent degassing, ix
ENTER
 KEY DEFINED, 26
enter term defined, xx
EQUIL, 53
Equilibration Time, 42
 Error Recovery, 42
Error messages, 29
Error Recovery Menu, 60
EXCEEDS FLOW RANGE, 126
exclamation points, 29
external events
 connection for, 8
External Inputs Test, 81

F

fields
 #Runs, 64
 @ Maximum Pres, 60
 AC Power Fail, 60
 conventions, xix
 Cursor Speed, 62
 DATE, 91
 DUE, 91
 Edit File, 43
 Equilibration Time, 42
 Event, 43
 File Name (FILES), 40
 File Name (QUEUE), 64
 File Protection, 62
 Flow, 40
 Flow (Purge), 48
 Flow Range, 92
 ITEM, 91
 Liquid End Type, 92
 Maximum Pressure, 38, 41
 Measured Time, 78
 Measured Vol, 77, 78
 Minimum Pressure, 38, 41
 Order, 64
 Pressure Units, 61
 PSI, BAR, or MPa, 48
 Purge, 48
 Purge Mode, 61
 Ready Output Active, 62
 Status Lock, 62
 Time (Purge), 48
 Time (Shutdown), 44
 Time (Solvent Program), 40
 Time (Timed Events), 43
 Time from Ready, 44
 Transducer Range, 82

VOL, 91

FILE

Delete, 38, 46
Edit, 37, 38
initializing, 49
Load, 45
Menu, 37

file linking, see Queue:, 63

File Name (FILES), 40

file numbers, 39

File Protection, 62

FILES

Copy, 38, 45
Delete, 38, 46
Edit, 37
 display, 39
 operation, 39
initializing, 49
Load, 45
Menu, 27, 37

Flow

 field of [PURGE] Menu, 48

Flow Calibration Test, 75

Flow Correction, 93

flow stability test

 example of running, 32

Flow Stability test, 72

front panel

 illustration, 25

fuse

 power entry module replacement, 116

H

Hardware modifications

 autosampler, 35

 pump, 35

Hardware Series test, 82

 results, 83, 85

high voltage, defined, xx, 95, 120

hints

 defined, xx

Hold, 52

HOLD, shown in Status, 53

hot surface

 defined, xx, 95, 120

I

Icons, xx

Increment (+) and decrement (-)

 keys

 DEFINED, 27

 illustrated, 25

inert assemblies, 110

INIT, 53

initializing a file, 49

injection valve/column bracket, see kits, manual injection
 valve bracket:, 139

inlet bracket, 116, 124
installation
 bench space needed, 7
 external events connection, 8
 power-on response, 8
 unpacking, 3
instrument control, 25

K

Kel-F seal, 100
keypad
 illustrated, 25
 instrument control, 25
 moving around, 23
keys
 [+] and [-], 24, 27
 [ENTER], 26
 [MENU], 26
 [PURGE], 26
 [RUN], 25
 [STATUS], 26
 [STOP], 26
 BLANK, 26
kits, 135
 Inert/Biocompatible LC Fittings, 137
 maintenance, 10 mL/min piston flush seal, 138
 maintenance, inert/biocompatible, 136
 maintenance, standard, 136
 manual injection valve bracket
 illustration, 141
 Manual Injection Valve Bracket, 139
 Piston Flush Seal, 138
 Solvent Inlet Tube, 138
 Solvent Tube Extension, 138
 Standard LC Fittings, 137

L

Lifetime History, 79
lifting, 5
linking, see Queue, 63
liquid end
 piston seal, 104
Liquid End Type, 92
liquid ends
 assembly, 104
 components, illustration, 103
 disassembly, 100
 inlet, illustration, 109
 installation, 108
 maintenance, 96
 removal, 98
Load (FILE(S)), 45
Load (QUEUE), 65

M

Main Menu P1500
 illustration, 27
maintenance
 check valves, see also check valves, 112
 drip tray, 114
 inert assemblies, 110
 kits
 contents of 10 mL/min piston flush seal, 138
 contents of inert/biocompatible, 136
 contents of standard, 136
 liquid end, see also Liquid Ends, 96
 period, extending, 94
 piston, 102
 piston flush seal, 105
 preparing the pump for, 96
 tips, 114
Maintenance Log, 90
 DATE, 91
 DUE, 91
 ITEM, 91
 menu, 90
 illustration, 91
 message, 90, 92
 setting intervals, 91
 table, 91
 using, 91
 VOL, 91
Maintenance Position, 92
Manual Injection Valve Bracket, 139
MAX PRESSURE, 126
Measured Parameters, 73
MENU
 KEY DEFINED, 26
menus
 Calibration, 75
 COMMANDS, 51
 Current History, 79
 Diagnostics, 72
 Edit (FILE), 38
 Edit (FILES), 39
 Edit (QUEUE), 64
 Error Recovery, 60
 FILE, 37
 FILES, 37
 Flow Correction, 93
 illustration of longer, xix
 Lifetime History, 79
 Liquid End Type, 92
 More (OPTIONS), 61
 OPTIONS, 59
 Options (FILES), 41
 QUEUE, 63
 Service, 79
 Shutdown, 44, 62
 Solvent Program, 40
 TESTS, 70
 Timed Events, 42

Menus and Screens, general description of

- Commands Menu, 27
- Diagnostics Menu, 72
- File Menu, 27
- Files Menu, 27
- Main Menu, 27
- Options Menu, 27
- Queue Menu, 27
- Status Screen, 28
- Tests Menu, 27

messages, 28

- confirmation, 28
- error, 29
- user, 28

More Menu (OPTIONS), 61

MOTOR STALLED, 126

Motor Step/Valve test, 82

N

narrow-bore

- hardware modifications, 35
- pump operation, 35
- specifications, 21

narrow-bore applications, 34

notes

- defined, xx

numeric entries, 27

O

options menu

- P1000, illustrated, 59
- P1500, illustrated, 59

Options Menu, 27, 59

- under Files, Edit, 41

Order (QUEUE), 64

OVER MAXIMUM, 126

P

P1000 and P100 Shutdown Menu, 43

passivation of stainless steel parts, 115

passive tests, 70

pause (QUEUE), 66, 68

pausing a queue, 68

piston

- flush seal, 105, 138
- holder housing, 100
- scratches, 89
- illustration, 104
- seal, 104

Piston flush seal kit, 138

power entry module

- fuse replacement, 116

POWER FAILURE, 126

power selection

- see voltage selection, 5

power-on response, 8

preset choices

- scrolling through, 27
- selecting from, 27

pressure

- setting limits, 38, 41

pressure units, 61

- example of changing, 29

Pressure Units, 61

Priming the Pump, 12

Program Version, 71

Pump

- carrying, 5

- front panel, illustration of, 25

- illustration with front cover removed, 97

- isocratic basics, 33

- LC basics, 33

- lifting and carrying, 5

- list of routine operations, 37

- operating statistics, 79

- P1000

 - description, 34

- P1500

 - description, 34

- placement, 7

- pressure, 38, 41

- rear panel, illustration of, 6

- repair, 116

- rules for operation, 23

- state changes, 79

- stopping, 50

- theory of operation, 119

pumps

- narrow-bore, 34

Purge

- field, of Purge Menu, 47

- internal limits, 47

- key defined, 26

- MENU, 47

- mode

 - example of changing, 30

- starting, 48

- stopping, 48

Purge Mode, 61

purging

- after priming the pump, 15

- example, 31

- solvents, 46

Q

Q (time), shown in Status, 53

Q RUN, 53

QEQUIL, 53

QINIT, 53

QREADY, 53

QSTOP, 53

Queue

- #Runs, 64

- adding lines, 64

- Delete command, 65
- deleting entire, 65
- deleting lines, 65
- description, 63
- editing, 64
 - illustration, 64
- holding a file in the, 68
- Load command, 65
- Menu, 27, 63
- illustrated, 63
- order, 64
- Pause command, 68
- running, 66
- stopping, 68

R

- RAM test, 80
- READY, 49
- Ready Output Active, 62
- READY, shown in Status, 53
- Rear panel
 - illustration, 6
- repair
 - fuse replacement, 116
 - solvent switching valve replacement, 116
- Reset, 51
- ROM test, 80
- RUN, 49, 50
 - KEY DEFINED, 25
 - shown in Status, 53

S

- safety
 - icons, xx, 95, 120
- safety certification
 - see Safety Information:, 95
- Safety Information vii, 23
- safety precautions
 - for troubleshooting, 120
- saving an entry, 24
- Screens
 - Status
 - P1000 illustrated, 28, 54
 - P1500 illustrated, 28, 54
- scrolling, 27
- seals
 - Kel-F, 100
 - piston, 104
 - piston flush, 105, 138
- select term defined, xx
- Service Menu, 79
 - illustration, 79
- shipping
 - damage, 3
- Shutdown File (P1500), 43
- Shutdown Menu (P1000), 43, 62
- Software Version, 71

- Solvent Program Menu, 40
- solvents
 - connecting, 9
 - disposal, ix
 - drip tray, 114
 - example of switching, 41
 - purging, 46
 - routine filtration, ix
- spare parts, list of, 23
- stainless steel
 - passivation, 115
- standard words, xx
- state changes, chronological list of, 79
- statistics, operating, 79
- status
 - display, 54
- Status, 53
 - P1000, 54
 - P1500, 54
- STATUS
 - KEY DEFINED, 26
- Status lock
 - differences between file protection, 62
- Status Lock, 62
- Status Menu
 - described, 28
 - P1000 illustrated, 54
 - P1500 illustrated, 54
- Status Messages, 53
- Status Screen
 - described, 28
 - P1000 illustrated, 54
 - P1500 illustrated, 54
- STOP
 - KEY DEFINED, 26
 - shown in Status, 53
- switching valve
 - replacement, 116
- SYNC, 53

T

- tests
 - active and passive, 70
 - Calibration, 75
 - Check Valve Test, 73
 - Cycle Step Count, 80
 - Display, 81
 - External Inputs, 81
 - Flow Stability, 72
 - Hardware Series, 82
 - initiating, 71
 - Measured Parameters, 73
 - Motor/Step Valve, 82
 - RAM, 80
 - results, 71
 - ROM, 80
 - Service, 79
 - Software Version, 71
 - Transducer Range, 82

- Tests Menu, 27, 70
 - illustration, 70
- Text conventions, xix
- theory of operation, 119
- Time
 - field of [PURGE] display, 48
 - shown in Status, 53
- time lines
 - adding, 40
 - chronological order of, 40
 - creating, 40
 - defined, 40
 - general rules, 40
 - number available, 41
- timed events
 - display, 42
- Timed Events Menu, 42
- Transducer Range, 82
- troubleshooting, 119
 - isolating the source of problem, 120
 - safety precautions for, 120

U

- unpacking, 3

V

- Visual clues on display, 24
- voltage select barrel, 5
- voltage selection, 5
 - barrel, 5
 - illustration, 7
 - instructions for, 5

Z

- ZERO FLOW RATE, 126
- Zero Pressure, 75