HL Series Syringe Pumps

Installation and Operation Guide

TELEDYNE ISCO
Everywhereyoulook™

Part #69-1263-015 of Assembly #60-1263-006

Revision S, February 2016

Foreword

This instruction manual is designed to help you gain a thorough understanding of the operation of the equipment. Teledyne Isco recommends that you read this manual completely before placing the equipment in service.

Although Teledyne Isco designs reliability into all equipment, there is always the possibility of a malfunction. This manual may help in diagnosing and repairing the malfunction.

If a problem persists, call or e-mail Teledyne Isco technical support for assistance. Simple difficulties can often be diagnosed over the phone. For faster service, please have your serial number ready.

If it is necessary to return the equipment to the factory for service, please follow the shipping instructions provided by technical support, including the use of the **Return Merchandise Authorization (RMA)** specified. **Be sure to include a note describing the malfunction.** This will aid in the prompt repair and return of the equipment.

Teledyne Isco welcomes suggestions that would improve the information presented in this manual or enhance the operation of the equipment itself.

Teledyne Isco is continually improving its products and reserves the right to change product specifications, replacement parts, schematics, and instructions without notice.

Contact Information

Customer Service

Phone:	(800) 228-4373	(USA, Canada, Mexico)
	(402) 464-0231	(Outside North America)
Fax:	(402) 465-3022	
Email:	IscoCSR@teledyne.com	

Technical Support

Phone:	Toll Free (866) 298-6174	(Samplers, Flow Meters and Multi-parameter Probes)
	Toll Free (800) 775-2965	(Syringe Pumps and Liquid Chromatography)
Email:	IscoService@teledyne.com	
Return equipment to:	4700 Superior Street, Lincoln, NE 68504-1398	

Other Correspondence

Mail to:	P.O. Box 82531, Lincoln, NE 68501-2531
Email:	IscoInfo@teledyne.com

Revised April 2014

NOTICE

If the pump has been used for pumping a hazardous or potentially lethal material:

· Do not return the pump without contacting the Teledyne Isco Service Department.

· Do not return the pump without first providing written guarantee that it has been decontaminated of hazardous or potentially lethal materials.

· Teledyne Isco reserves the right to refuse shipment if no decontamination assurance has been provided prior to shipment. Failure to decontaminate a pump may result in legal action.

Fluids Certified for Isco HL Pumps

⚠ WARNING

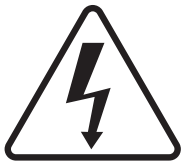
Pumping fluids that are not compatible with the HL Series Pump may damage critical components, resulting in property damage, personal injury, or even death. Users who pump fluids other than those listed below do so at their own risk.

The fluid-contacting materials within the HL Series Syringe Pump have been tested and certified to be compatible with the following fluids:

• ethane	• ethylene	• propane	• propylene
• butane	• butadiene	• hexane	• gasoline
• diesel fuel	• jet fuel	• ammonia	• methanol
• isopropanol	• acetone	• acetonitrile	• heptane
• benzene	• ethylbenzene	• methane	• water

Consult with Isco before using any chemical not listed above.

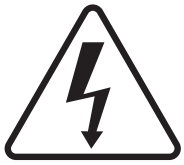
Warnings and Cautions



The lightning flash and arrowhead within the triangle is a warning sign alerting you to “dangerous voltage” inside the product.

The exclamation point within the triangle is a warning sign alerting you to important instructions in this manual.

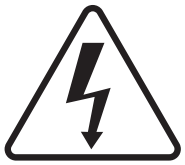
Symboles de Sécurité



Ce symbole signale la présence d’un danger d’électrocution.

Ce symbole signale l’existence d’instructions importantes relatives au produit dans ce manuel.

Warnungen und Vorsichtshinweise



Der gepfeilte Blitz im Dreieck ist ein Warnzeichen, das Sie vor „gefährlichen Spannungen“ im Inneren des Produkts warnt.

Das Ausrufezeichen in Dreieck ist ein Warnzeichen, das Sie darauf aufmerksam macht, daß wichtige Anleitungen zu diesem Handbuch gehören.

Advertencias y Precauciones

Esta señal alerta sobre la presencia de alto voltaje en el interior del producto.

Esta señal le advierte sobre la importancia de las instrucciones del manual que acompañan a este producto.

"To prevent damaging the instrument or injuring yourself, it is absolutely necessary that you understand everything in English, above all, technical terms, before operating the instrument. Otherwise, it is necessary for you to receive complete instruction from someone qualified who understands both the instrument and English very well."

"Um eine Beschädigung des Gerätes oder eine Gefährdung des Anwenders zu vermeiden ist es notwendig, daß dieser vollstandig die englische Sprache und die technischen Bezeichnungen beherrscht. Oder der Anwender muß von einer Person eingeübt werden, die bereits vorher dieses Gerät bedienst hat."

"Pour empêcher dommage à l'instrument ou blesser vous-même, il faut absolument que vous compreniez tout en anglais, surtout les termes techniques, avant d'actionner l'instrument. Autrement, il faut que vous receviez l'instruction parfaite d'une personne très compétente qui comprend bien les deux l'instrument et anglais."

"Para prevenir cualquier daño en el instrumento o en el operador, es necesario que el usuario comprenda perfectamente el lenguaje inglés y las términos técnicos intrínsecos, o bien ser formado por una persona que haya trabajado ya previamente con este instrumento."

"For a forhindre skade på instrumentet eller operatøren er det nødvendig at brukeren har full forståelse for det engelske sprak og tekniske uttrykk Ellers må brukeren få opplæring av en person, som kan engelsk, for instrumentet tas i bruk."

"För att förhindra skade på instrumentet eller operatören, år det nötvändigt att användaren har fullständiga kunskaper i det engelska språket och dess tekniska termer, eller utbildas av en person, som tidigare brukat instrumentet."

"For at undgå skade på produktet eller på brugeren er det nødvendigt at brugeren til fulde forstår det engelske sprog for at forstå den tekniske formulering i den engelske manual. I modsat fald skal brugeren modtage træning, inden apparatet tages I drift."

Laitteelle tai käyttäjälle aiheutuvien vahinkojen välttämiseksi on tärkeää, että käyttäjä hallitsee englannin kielen ja englantilaiset tekniset termit tai on saanut käyttöopastuksen englantia osaavalta henkilöltä.

“Per evitare danni allo struménto od incidenti all’operatore, é necessario che l’utilizzatore abbia una completa conoscensza della lingua inglese oppure che venga istruita da una persona che abbia utilizzato precedentemente questo strumento.”

“Para impedir qualquer dano no aparelho ou ferimentos parao operador, é necessario que o utilizador tenha um conhecimento completo da lingua inglesa e dos respectivos termos técnicos, ou seja, treinado por uma pessoa que tenha esse conhecimento, antes de operar com este aparelho.”

“Για την αποφυγη βλαβης του οργανου ‘η τραυματισμου του χρηστη, ειναι απαραιτητο ο χρηστης να γνωριζει καλα την αγγλικα γλωσσα καθως και τους σχετικους τεχνικους ορους, η να εκπαιδευτει απο ατομο το οποιο εχει προνφουμενως εργαστει πανω στο οργανο αυτο.”

С цел да избегне повреда на апаратурата или нараняване на оператора е необходимо клиента добре да владее английски език и техчническата терминолгия, която е използувана в описанието или да бъде обучен от лице, което е вече работило с такъв апарат.

Figyelmeztetés! A készülék meghibásodásának valamint a kezelö sérülésének megelözése érdekében a felhasználónak feltétlenül értenie kell az angol nyelvet, ezen belül a müszaki kifejezéseket, vagy pedig a használatba vételt megelözöen a készülék kezelésében már gyakarlott személy által történö betanitás szükséges!

CAUTION:
Avoid spills! Liquids associated with this instrument may be classified as carcinogenic, biohazardous, flammable, or radioactive. Should these liquids be used, it is highly recommended that this application be accomplished in an isolated environment designed for these types of materials in accordance with federal state and local regulatory laws and in compliance with your organization's chemical/hygiene plan in the event of a spill.
In all cases, when using Isco, Inc. instrumentation, prudence and common sense must be used.

WARNING:
Pumping fluids that are not compatible with the HL Series Pump may damage critical components, resulting in property damage, personal injury, or even death. Users who pump fluids other than those listed below do so at their own risk.
The fluid-contacting materials within the HL Series Syringe Pump have been tested and certified to be compatible with the following fluids:

- **ethane**
- **ethylene**
- **propane**
- **propylene**
- **butane**
- **butadiene**
- **hexane**
- **gasoline**
- **diesel fuel**
- **jet fuel**
- **ammonia**
- **methanol**
- **isopropanol**
- **acetone**
- **acetonitrile**
- **heptane**
- **benzene**
- **ethylbenzene**

Consult with Isco before using any chemical not listed above.

WARNING:
Pinch point. This symbol warns you that your fingers or hands will sustain serious injury if you place them between the moving parts of the mechanism near this symbol.

WARNING:
Avoid hazardous practices! If you use this instrument in any way not specified in this manual, the protection provided by the instrument may be impaired; this will increase your risk of injury.

WARNING:
Explosion Hazard. Substitution of components may impair suitability for use in Class I, Division 2 environments.

AVIS: Éviter de répandre! Les liquides qui sont pompés dans cet instrument peuvent être cancérigènes, hasards biologiques, inflammables, ou radioactifs. Si vous devez utiliser ces liquides hasardeux, il est très recommandé que vous le faites à l'intérieur d'un environnement isolé conçu pour tels liquides. Cet environnement isolé devrait être construit selon les règlements fédéraux, provinciaux, et locaux, aussi que le plan de votre organisation qui concerne l'évènement d'un accident avec les matières hasardeuses. En tout cas, utilisez toujours l'instrumentation d'Isco avec prudence et sens commun.

ATTENTION:
Risque de pincement. Ce symbole vous avertit que les mains ou les doigts recevront une blessure sérieuse si vous les mettez entre les éléments en mouvement du mécanisme près de ce symbole.

ATTENTION:
Éviter les usages hasardeux! Si vous utilisez cet instrument d'une manière autre que celles qui sont specifiées dans ce manuel, la protection fournie par l'instrument peut être affaiblie; cela augmentera votre risque de blessure.

HL Series Syringe Pumps

Table of Contents

Section 1 Introduction

Section 2A Liquid System Connections & Accessories

Section 2B Liquid System Connection & Accessories

Section 2C Liquid System Connection & Accessories

Section 3 Single & Multiple Independent Pump Operation

Section 4 Serial Interface

Section 5 Pump Maintenance & Repair

Section 6 Continuous Flow Introduction, Installation, & Operation

Section 7 Analog/Serial Control

List of Figures

List of Tables

HL Series Syringe Pumps

Section 1 Introduction

1.1 Introduction

This manual is intended to help you get your pumps set up and running as quickly and easily as possible.

1.1.1 Specifications

The technical specifications for the HL Series Syringe Pumps are detailed in Tables 1-1 through 1-4.

☑ *Note*

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, T4; and Zone 2 EEx nc IIC T3 hazardous locations and non-hazardous locations only.

⚠ WARNING

Explosion Hazard. Substitution of components may impair suitability for use in Class I, Division 2 environments.

Figure 1-1 HL Series Syringe Pump (500HL shown)

Table 1-1 100HLX Technical Specifications	
POWER REQUIREMENTS ⚠ See section 1.4, Installation Instructions	117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 101.09 cm / 13.59 cm
WEIGHT	PUMP: 32.8 kg CONTROLLER: 2.96 kg
FLOW RATE RANGE	0.01 µl/min to 25 ml/min (for any pressure up to 689.5 bar)
FLOW RATE ACCURACY[a]	± 0.3% (maximum 0.25 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	0.01 µl/min (1.0 µl/min in Constant Pressure Mode)
ANALOG OUTPUT ACCURACY[b]	± 1% of selected range
DISPLACEMENT RESOLUTION	1.93 nl
REFILL TIME	2.1 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 18 ml/min at any pressure from 0 to 689.5 bar
PRESSURE RANGE	0.6895 to 689.5 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[c]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.12% of full scale/°C
HUMIDITY	95% maximum
CYLINDER CAPACITY	102.93 ml
DEAD (HEADSPACE) VOLUME[d]	1.30 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Using water at 137.9 bar and a temperature controlled environment at 30°C.

b. The analog output is an optional accessory.

c. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.

d. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-2 260HL Technical Specifications	
POWER REQUIREMENTS ⚠ See section 1.4, Installation Instructions	117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 101.09 cm / 13.59 cm
WEIGHT	PUMP: 32.8 kg CONTROLLER: 2.96 kg
FLOW RATE RANGE	See Figure 1-2.
FLOW RATE ACCURACY[a]	± 0.5% (maximum 0.50 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[b]	± 1% of selected range
DISPLACEMENT RESOLUTION	6.65 nl
REFILL TIME	1.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 64 ml/min at any pressure from 0 to 517.1 bar
PRESSURE RANGE	0.6895 to 517.1 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[c]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.15% of full scale/°C
HUMIDITY	95% maximum
CYLINDER CAPACITY	266.05 ml
DEAD (HEADSPACE) VOLUME[d]	2.10 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Using water at 137.9 bar and a temperature controlled environment at 30°C.

b. The analog output is an optional accessory.

c. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.

d. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-3 500HL Technical Specifications	
POWER REQUIREMENTS ⚠ See section 1.4, Installation Instructions	117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 102.36 cm / 13.59 cm
WEIGHT	PUMP / CONTROLLER 33.25 kg / 2.96 kg
FLOW RATE RANGE	See Figure 1-3.
FLOW RATE ACCURACY[a]	± 0.5% (maximum 1.0 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[b]	± 1% of selected range
DISPLACEMENT RESOLUTION	12.68 nl
REFILL TIME	1.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 122 ml/min at any pressure from 0 to 258.6 bar
PRESSURE RANGE	0.6895 to 258.6 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[c]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.15% of full scale/°C
HUMIDITY	95% maximum
CYLINDER CAPACITY	507.38 ml
DEAD (HEADSPACE) VOLUME[d]	4.00 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Using water at 137.9 bar and a temperature controlled environment at 30°C.

b. The analog output is an optional accessory.

c. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.

d. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

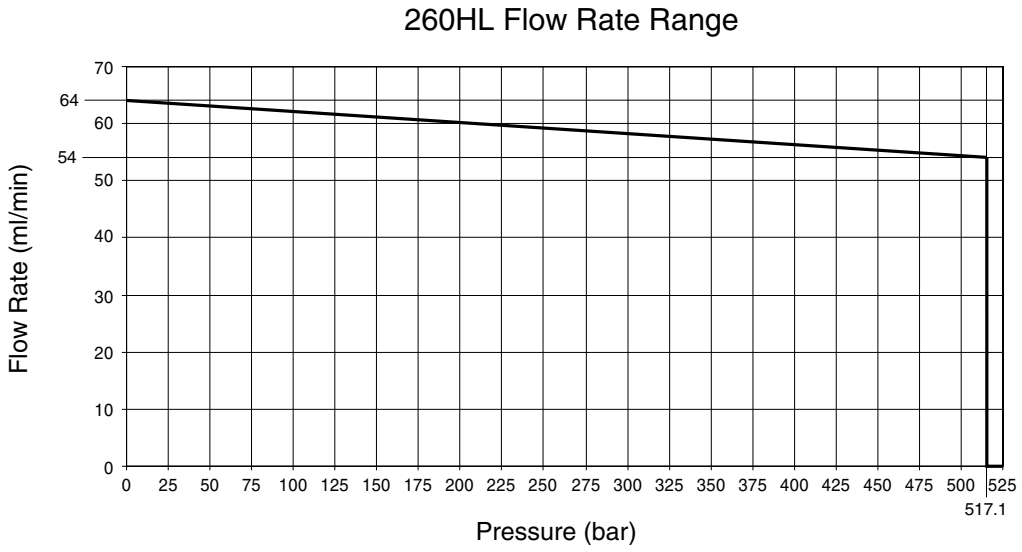
Table 1-4 1000HL Technical Specifications	
POWER REQUIREMENTS ⚠ See section 1.4, Installation Instructions	117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 102.36 cm / 13.59 cm
WEIGHT	PUMP / CONTROLLER 38.5 kg / 2.96 kg
FLOW RATE RANGE	See Figure 1-4.
FLOW RATE ACCURACY[a]	± 0.5% (maximum 1.5 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[b]	± 1% of selected range
DISPLACEMENT RESOLUTION	63.42 nl
REFILL TIME	1.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 245 ml/min at any pressure from 0 to 137.9 bar
PRESSURE RANGE	0.6895 to 137.9 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[c]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.12% of full scale/°C
HUMIDITY	95% maximum
CYLINDER CAPACITY	1015.0 ml
DEAD (HEADSPACE) VOLUME[d]	11.0 ± 0.7 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Using water at 137.9 bar and a temperature controlled environment at 30°C.

b. The analog output is an optional accessory.

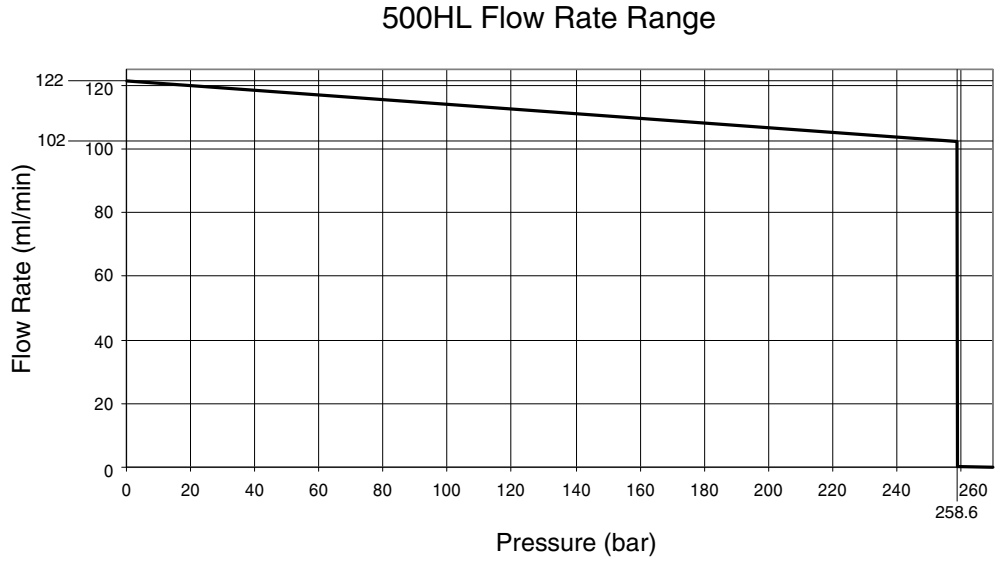
c. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.

d. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.



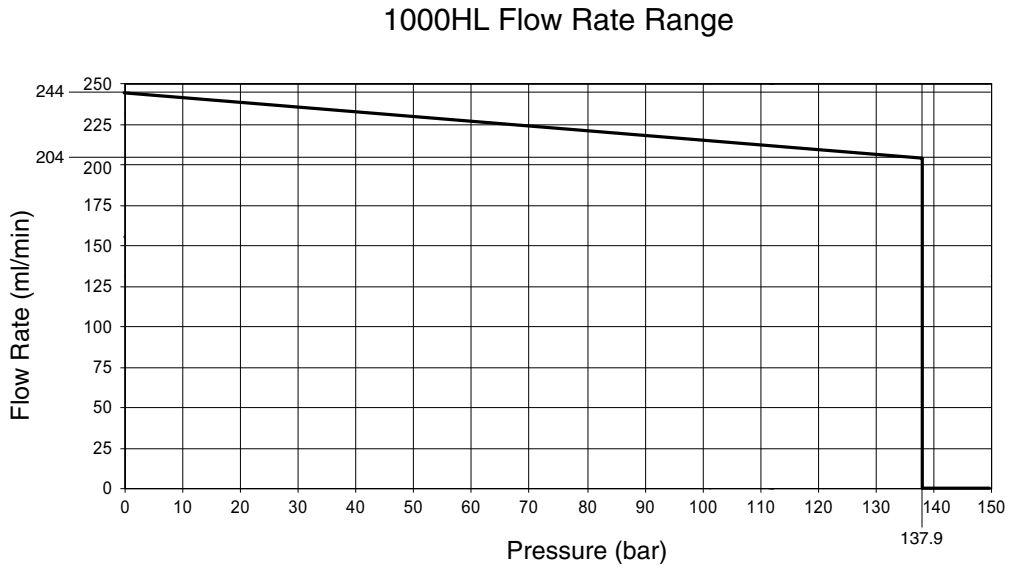
Flow Rate (ml/min)	Max. Pressure (bar)
0 to 54	517.1
54 to 64	(64 ml/min – flow rate) × 51.5

Figure 1-2 260HL flow rate range



Flow Rate (ml/min)	Max. Pressure (bar)
0 to 102	258.6
102 to 122	(122 ml/min – flow rate) × 13

Figure 1-3 500HL flow rate range



Flow Rate (ml/min)	Max. Pressure (bar)
0 to 204	137.9
204 to 244	(244 ml/min – flow rate) × 3.45

Figure 1-4 1000HL flow rate range

Table 1-5 Pump Controller Key Functions

Key	Description
A, B, C, D	Softkeys; used to select displayed options.
PRGM GRAD	[Function not available with HL pumps.]
CONST PRESS	Constant pressure: Puts pump in constant pressure mode.
CONST FLOW	Constant flow: Puts pump in constant flow rate mode.
STORE	Stores the current program in nonvolatile memory and exits programming mode.
LIMITS	Displays and allows changes to the maximum and minimum pressure and flow rate limits.
RAPID PRESS	Rapid pressure: Allows rapid pressurization to the stable pressure point and then switches automatically to constant flow. (Available in constant flow mode only.) NOTE: This feature is automatic, *i.e.* RAPID PRESS is pressed only once and the user does not enter a pressure; although, entering a target pressure may speed equilibration.
RECALL	Replaces the current program with one recalled from nonvolatile memory.
ACC CTRL	Accessory control: Manually operates accessories such as valves.
ZERO PRESS	Zero pressure: Sets pressure display to zero. Active only from -750 to +750 psi.
CLEAR ENTRY	Clear the last digit entered from the numeric key.
MENU	Accesses software to set operational modes, units, and other optional parameters.
HELP	Provides information.
HOLD	Freezes the program clock. The unit will continue at the current gradient parameters.
REFILL	Turns on pump drive motor to move piston downward at a rate previously programmed.
RUN	Turns on pump drive motor to move piston upward in a previously programmed mode, such as “CONSTANT FLOW” or “CONSTANT PRESSURE.”
STOP	Stops the drive motor.
ENTER	Enters selected values to memory.
NUMBER KEYS	These keys are used to make menu selections and enter values when setting parameters.

1.2 Controls and Indicators

The pump controller, which is designed to conveniently sit on top of the pump base, regulates all pumping functions. Controller input is made through the keypad on the controller front panel. The controller front panel is shown in Figure 1-5 and detailed in Table 1-6. Table 1-5 details the key functions.

The rear panel of the pump controller contains several input and output connectors, detailed in Table 1-7, and shown in Figure 1-6.

The only operational control on the pump itself is the mains power switch, shown in Figure 1-8. The rear panel contains several connectors, detailed in Table 1-8, and shown in Figure 1-7.

Figure 1-5 Pump controller Front Panel

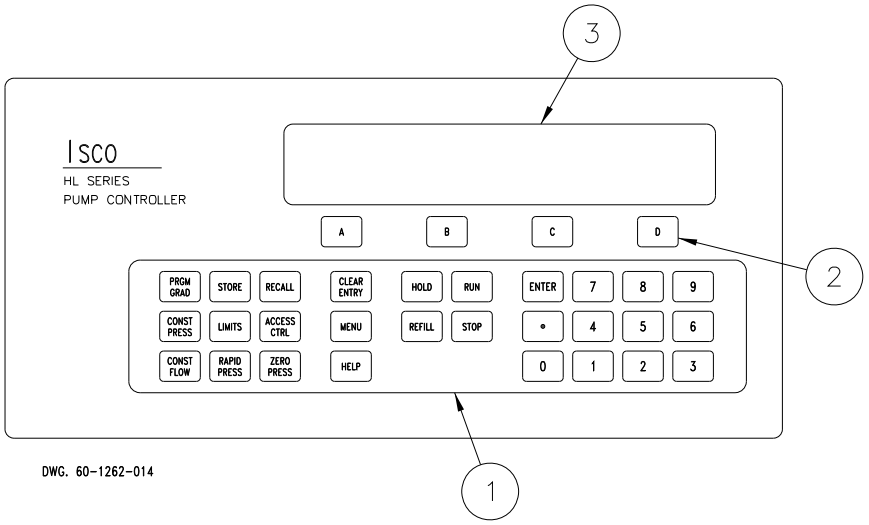
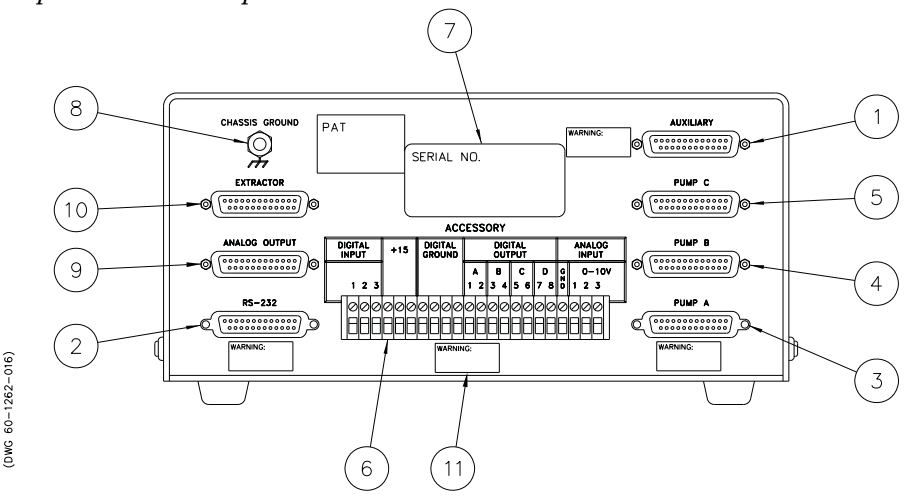


Table 1-6 Pump Controller Front Panel Label

Item No. on Figure 1-5	Connector	Description
1	Programming keypad	Used to program controller.
2	Softkeys	Labeled A, B, C, or D; used to select menu items displayed on the liquid crystal display.
3	Liquid crystal display	40 Characters × 4 line.

Figure 1-6 Pump controller rear panel connectors



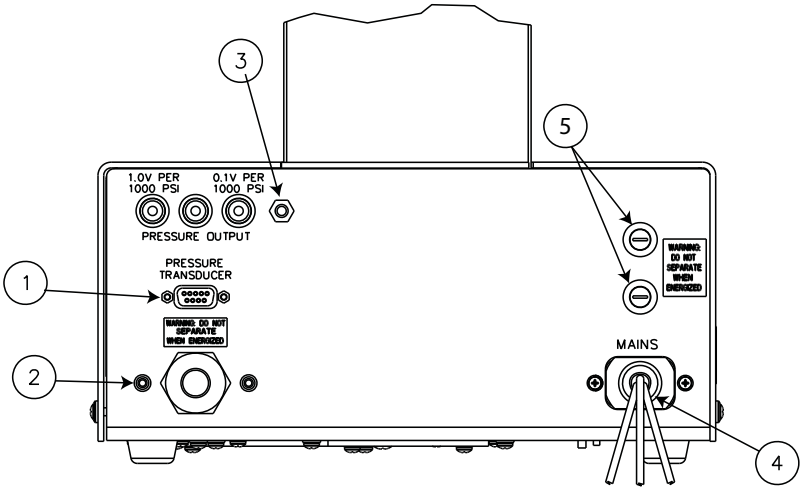
⚠ WARNING

Explosion Hazard. The area must be known to be non-hazardous before servicing/replacing the unit and before installing or removing I/O wiring. Do not disconnect equipment unless power has been disconnected and the area is known to be non-hazardous.

Table 1-7 Pump Controller Rear Panel Connectors

Item No. on Figure 1-6	Connector	Description
1	AUXILIARY	Provides connection for pump external controls and to future accessories.
2	RS-232	This serial port connector may be used with an RS-232 cable to place the pump under computer control.
3	PUMP A	This plug connects the control cable from the pump rear panel. This connection should be secured with the thumbscrews. **IMPORTANT**: The pump A connector is the only input power connector on the rear panel of the controller. During single pump operation, the pump must be attached to this connector to supply power to the controller. ⚠ **WARNING – Do not connect or disconnect the control cable when the pump is connected to the mains voltage.**
4	PUMP B	This connector is only used during multiple pump operation. The control cable from the rear panel of the second pump is attached to this connector.
5	PUMP C	This connector is only used during multiple pump operation. The control cable from the rear panel of the third pump is attached to this connector.
6	ACCESSORY	These terminals allow connection of input and output signals (such as analog controls and external RUN/STOP).
7	SERIAL TAG	This tag indicates the serial number of the instrument.
8	CHASSIS GROUND	Ground point for high static or remote controller installations.
9	ANALOG OUTPUT	Optional circuit provides flow rate and volume outputs. Not available for HL systems.
10	SFX220/VALVES	Optional circuit provides motor drive for valve operation.
11	WARNING LABEL	⚠ **WARNING – Do not separate connections when circuits are energized.**

Figure 1-7 Pump rear panel connectors



⚠ WARNING

Explosion Hazard. The area must be known to be non-hazardous before servicing/replacing the unit and before installing or removing I/O wiring. Do not disconnect equipment unless power has been disconnected and the area is known to be non-hazardous.

Table 1-8 Pump Rear Panel Connectors

Item No. on Figure 1-7	Connector	Description
1	Pressure transducer	The pressure transducer cable must be plugged in for the pump to operate.
2	Control cable	This cable connects the pump to the controller.
3	Chassis ground	Ground point for high static installations.
4	AC mains power	120 Volt Systems: Green/Yellow - Earth Black - AC hot White - AC neutral 234 Volt Systems Green/Yellow - Earth Brown - AC hot Blue - AC neutral **⚠ WARNING – Do not separate connections while circuits are energized. AC mains power must be permanently wired to the AC power source. Never attach a plug or power cord to the wires. All input and output circuits must be wired using Division 2 wiring methods as specified in Article 501-4(b) of the National Electrical Code, NFPA 70 for installations in the U.S. In other countries local codes apply.**
5	Mains fuses	Call Teledyne Isco for replacement.

Figure 1-8 Pump front panel controls

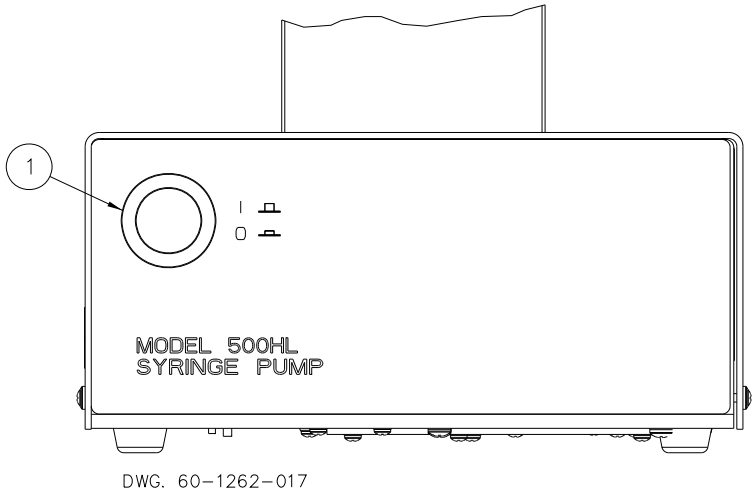


Table 1-9 Pump Front Panel

Item No. on Figure 1-8	Connector	Description
1	Mains power switch	Disconnects power from the pump circuits for setup changes, such as connecting the controller. "1" = mains power is applied to the pump circuitry. "0" = mains power is removed from the pump circuitry.

1.3 Unpacking

After removing the pump, controller, and accessories from the shipping carton, examine them for signs of shipping damage. Be sure no internal parts have shaken loose in transit. If there is any shipping damage, file a claim with the delivering carrier immediately.

Compare the contents of the boxes with the enclosed packing slip. If there are any shortages, contact Isco immediately.

1.4 Electrical Connections

The pump controller may be placed on top of the pump, as shown in Figure 1-1. Power is supplied to the pump controller through the control cable.

⚠ CAUTION

All connections between the pump and controller should be made BEFORE the pump is connected to mains power.

1. Connect the pressure transducer cable (which originates from the top of the pump cylinder) to the nine pin sub-D PRESSURE TRANSDUCER connector on the pump rear panel (Figure 1-7). Be sure to tighten the screws.

2. Connect the control cable (which originates from the pump rear panel) to the PUMP A connector on the rear panel of the controller (Figure 1-6), and tighten the screws. This cable must be plugged into the PUMP A connector.

There are three PUMP connectors on the rear of the controller. Only PUMP A is wired to supply power to the controller; therefore, one pump must be attached to the PUMP A connector.

3. Check the serial number tag to make sure the voltage rating of the pump is correct.

⚠ WARNING

Do not make or separate connections while circuits are energized. AC mains power must be permanently wired to the AC power source. Never attach a plug or power cord to the wires. Electrical connections must be made according to governing directives.

4. Connect the AC Mains Power wiring from PUMP A to an AC power source. All input and output circuits must be wired using Division 2 wiring methods as specified in Article 501-4(b) of the National Electrical Code, NFPA 70 for installations.

1.5 Preliminary Checkout

After the electrical connections have been completed, follow this brief test of the pump's operation:

Hard reset

Perform a hard reset:

1. Ensure that power has been removed from the pump controller.
2. Press and hold the CLEAR ENTRY key on the front panel keypad.
3. While holding the CLEAR ENTRY key, apply power to the pump controller. Keep the CLEAR ENTRY key pressed for one second.
4. Release the key and turn the unit back to STANDBY.
5. Then turn the instrument back ON and execute a system reset (described next).

System Reset

A system reset completely clears any user programmed settings. It will erase all programs and return units and limits to factory settings. If the ZERO PRESS key has been used, the corrected offsets will be lost. This resets *all* pumps that are connected to the controller.

1. Press the orange MENU key.
2. Select number 5. SYSTEM RESET.
3. Press softkey A, CONTINUE.

System Checks

Note

Preliminary checkout the pump is performed without fluid in the pump.

1. The display will briefly show the software revision on the first line; and the pump model(s) connected to the controller on the following lines, Figure 1-9.

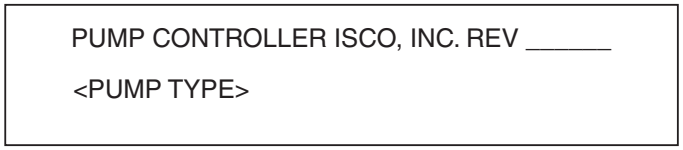


Figure 1-9 Status Screen

2. Check the upper left corner of the controller screen. The current pump mode will be presented in a two-letter abbreviation, *e.g.* CF for constant flow. This will be followed by a lowercase letter indicating the current pump, *e.g*. lowercase "a" indicates that pump A is the current pump. The current pump is the one for which parameters are being set.
   a. If a pump other than pump A is currently selected:

      On the lower right corner of the screen, directly over softkey D, are the words "SELECT PUMP."

      Press softkey D and then softkey A to select pump A. The display will automatically switch to the run screen, and "a" will be displayed in the upper left corner.
3. Press the orange MENU key on the controller front panel.
4. Press number 6 to set the display contrast. Use softkeys B and C to set the optimum contrast for your viewing conditions. Press softkey D, PREVIOUS, to return to the menu screen.
5. Press number 1 to select UNITS.
6. Press number 3 to select PSI for the pressure units.
7. Press number 5 to select ML/MIN for the flow units. The first line of the display will show the selected units.
8. Press softkey D, PREVIOUS, to return to the main menu.
9. Press softkey D, RETURN, to exit the main menu.
10. Push the blue CONST FLOW key to set the pump mode to constant flow. CFa will be displayed in the upper left corner of the screen.
11. Press softkey A, FLOW RATE. The words "ENTER FLOW RATE" should flash on the display. Use the numeric keys to enter "1", "0", a flow rate of 10 ml/min. Press the ENTER key to load this setpoint.

> ☑ ***Note***
>
> If you make an error, press the orange CLEAR ENTRY key to delete it.

12. Press the blue RUN key. Observe the flow rate displayed on the first line. After a few moments, the setpoint and flow rate display should match.
13. Once the setpoint and flow rate match, press the STOP key.

    If more than one pump is connected to the controller, you will be prompted to press softkey A to stop pump A, B to stop pump B, etc.

    Press softkey A to stop pump A or softkey D to stop all pumps.

    If you encountered any problems during the preliminary checkout, please contact the Isco Service Department. The number is (800) 775-2965 or (402) 464-0231.

HL Series Syringe Pumps: Models 100HL and 260HL

Section 2A Liquid System Connections & Accessories

About This Section:

The following section is divided into three parts, 2A, 2B, and 2C. Section 2A covers the liquid system connections and accessories for the Isco 100HL and 260HL syringe pumps. Sections 2B and 2C cover the same topics for the 500HL and 1000HL syringe pumps, respectively.

The installation procedures for the HL Series pumps have been divided in this way for your convenience. The 100HL and 260HL pumps all come with 1/8" standard Valco ports. The 500HL and 1000HL ports are 1/8" pipe thread fittings. Because of this difference, the packages, tubing, and options have different part numbers. Additionally, these pumps are typically used for different applications; therefore, the optional kits and accessories differ.

If you are setting up continuous flow or air valve systems, there are appendices for these systems located at the rear of this manual, which contains plumbing suggestions and outlines basic operation.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

2A.1 Introduction

This section discusses liquid system connections in general, and details the accessory package installation. It also covers the installation of fluid connection accessories, temperature and pressure control accessories, optional kits and attachments, and software options.

If you are familiar with syringe pumps, you may wish to skip over the general information and helpful tips presented in section 2A.3, liquid system connections, and proceed directly to your package installation instructions. Use the following references to locate the desired section.

☑ *Note*

When operating at flow rates at or below 100 µl/min, it is strongly suggested that an insulating cover or cooling jacket be installed. See Temperature Controls in the following list.

Fluid Connection Accessories (section 2A.4):

Pump refill kit, 2A.4.1
Outlet valve package, 2A.4.2
In-line filter package, 2A.4.3

Temperature and Pressure Controls (section 2A.5):

Cylinder insulating cover, 2A.5.1
Cooling jacket package, 2A.5.2
Back pressure regulators, 2A.5.3

Nitrogen Purge (section 2A.6)

Optional Accessories (section 2A.7)

2A.2 Fluids Certified for Isco HL Pumps

⚠ WARNING

Pumping fluids that are not compatible with the HL Series Pump may damage critical components, resulting in property damage, personal injury, or even death. Users who pump fluids other than those listed below do so at their own risk.

The fluid-contacting materials within the HL Series Syringe Pump have been tested and certified to be compatible with the following fluids:

• ethane	• ethylene	• propane	• propylene
• butane	• butadiene	• hexane	• gasoline
• diesel fuel	• jet fuel	• ammonia	• methanol
• isopropanol	• acetone	• acetonitrile	• heptane
• benzene	• ethylbenzene	• methane	

Consult with Isco before using any chemical not listed above.

2A.3 Liquid System Connections

The following section provides general information concerning syringe pumps, some tips about liquid connections, and information about tubing and tubing cutting procedures. The accessory package is also discussed.

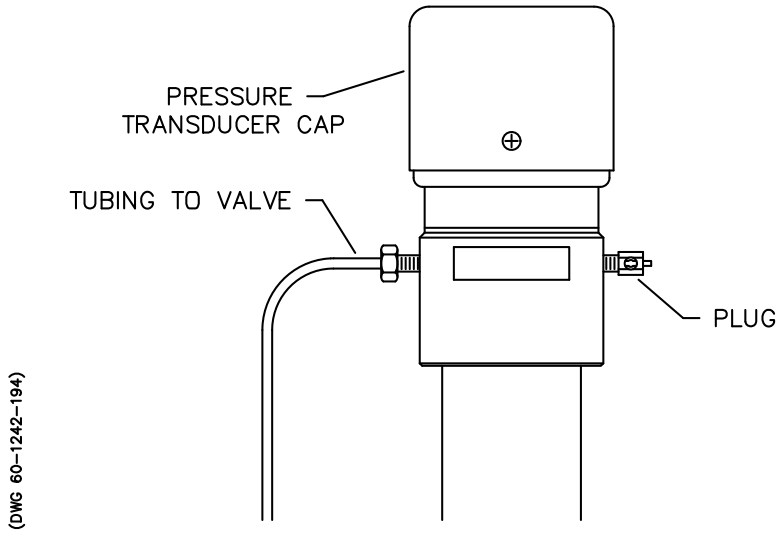
2A.3.1 Ports

There are two ports in the pump cylinder cap. Either port can serve as the inlet or outlet. As shown in Figure 2A-1, you may plug one port and use a single port as both the inlet and outlet.

Figure 2A-1 Liquid system plumbing connections

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.



2A.3.2 Installation Tips

- Be sure to keep the tubing as straight as possible at the end, as this will make it easier to install the ferrules.
- Be sure to cut the ends of the tubing squarely.
- Don't leave burrs on the ends of the tubing.
- When installing ferrules on the tubing, be sure the tubing extends beyond the ferrule to allow for proper crimping.
- If the connection is leaking, retighten fittings.
- Push the tubing completely into the port before tightening the nut.
- When connections are made to the cylinder cap, the pressure reading may be affected. If the pressure no longer reads zero, push the pressure zero key on the front panel of the controller to readjust.

2A.3.3 Tubing Cutting

To prevent possible problems, it is important to squarely cut the tubing. Square ends will be easier to insert through the ferrule and will lower the dead volume.

It is recommended that electrochemically machined steel tubing be used throughout the plumbing system. Electrochemically machined tubing has flat, burr-free ends for minimum dead

volumes and is free of cutting residues. Pre-cut, electrochemically machined tubing is available through many chromatographic supply distributors in assorted lengths.

A somewhat less desirable alternative is to purchase a tubing cutter designed to handle steel tubing.

For quick fixes, the tubing may also be cut by hand with the following procedure. A jewelers file, goggles, and two pairs of pliers are necessary for this operation.

To cut the tubing by hand

1. Wear goggles. Using a fine jewelers file, score the tubing around its entire circumference.
2. Secure the tubing with pliers on each side of the score line leaving approximately 1.5 mm between each set of pliers and the score line. Care must be taken not to squeeze the tubing too tightly as that will flatten or deform the exterior of the tubing.
3. With the pliers, bend the tubing back and forth to cause cracking at the score line. The bending should be done in two places to reduce the chance of squashing the tubing.
4. It may be necessary to deburr the outside of the tubing ends with the file. Make sure the tubing ends are clean and the inner bore is clear before installing the cut tube.

> ☑ ***Note***
>
> It is often impossible to remove a burr that blocks the inner bore.

2A.3.4 Accessory Package

The accessory packages for both pumps contain Valco fittings for 1/8" tubing which allow you to attach tubing to the pump, a reducing adapter for use with 1/16" tubing, and the appropriately sized cylinder seals.

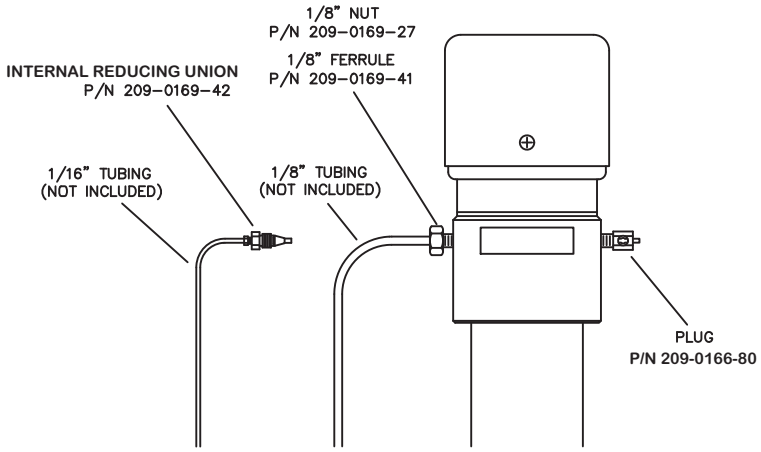
To install the 1/8" fittings (Figure 2A-2)

1. Slide first the 1/8" nut and then the ferrule over the tubing.
2. Push the tubing all the way into the port.
3. hold the tubing in place and tighten the nut.

Figure 2A-2 Accessory package installation

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.



To install the 1/16" fittings

1. The reducing adapter must be used. Loosen the 1/16" nut until it is held by a few threads.
2. Insert the adapter into the port and finger tighten the fittings.
3. Retighten the 1/16" nut until it is also finger tight.
4. Tighten the 1/8" nut with a wrench to crimp the ferrule.
5. Insert the 1/16" tubing through the 1/16" nut until it stops.
6. Tighten the 1/16" nut.

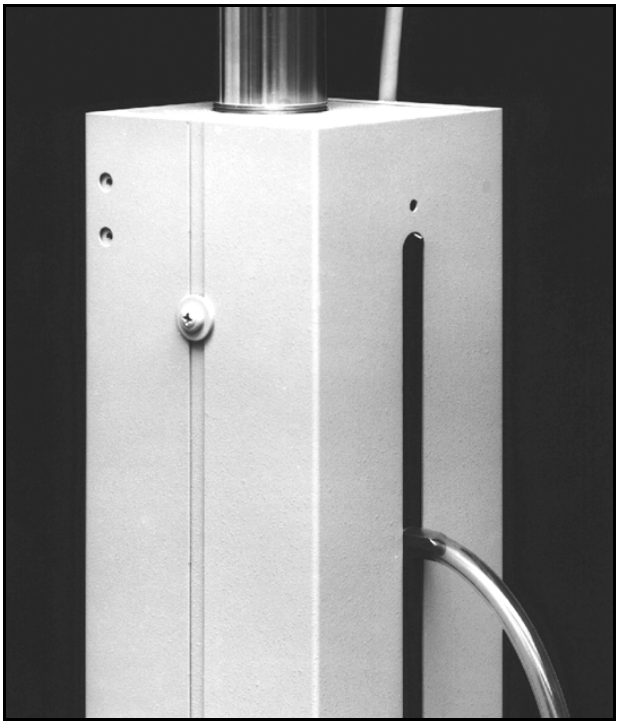
☑ *Note*

It is recommended that after tightening, the fittings be removed and examined.

2A.3.5 Drain Tube

The overflow outlet on the pump cylinder provides a means of draining fluid from seal leakage. Use the 1/4" ID flexible tubing included with the accessory package, to divert the leakage away from the pump. To install the drain tube, simply place one end of the tubing over the end of the drip pan outlet, shown in Figure 2A-3.

Figure 2A-3 Drain tube installation



2A.4 Fluid Connection Accessories

The optional accessories discussed in this section are used to make fluid connections from the pump(s) to another apparatus. These include devices such as fluid reservoirs, etc.

2A.4.1 Refill Kit

The optional refill kit is detailed in Table 2A-1. This kit provides a high pressure, 2-way valve which connects to the pump inlet and allows for filling from a fluid reservoir.

Table 2A-1 Optional Refill Kit Package (68-1247-077)

Qty.	Part Number	Description
1	60-1243-659	Valve spacer
1	209-0098-05	2-way straight valve, 1/8" OD, bracket mounted
1	023-0504-02	1.5 m - 0.065 ID Teflon tubing
1	60-1243-658	Stainless steel tubing, 1/8" OD × 0.069 ID
1	209-0161-66	Nut 1/8" OD tubing
1	209-0161-67	Ferrule 1/8" OD tubing
1	209-9012-10	10 micron filter
1	60-1243-391	1.5 m coiled, stainless steel tubing, 1/8" OD × 0.069 ID
Appropriate screws and washers also included		

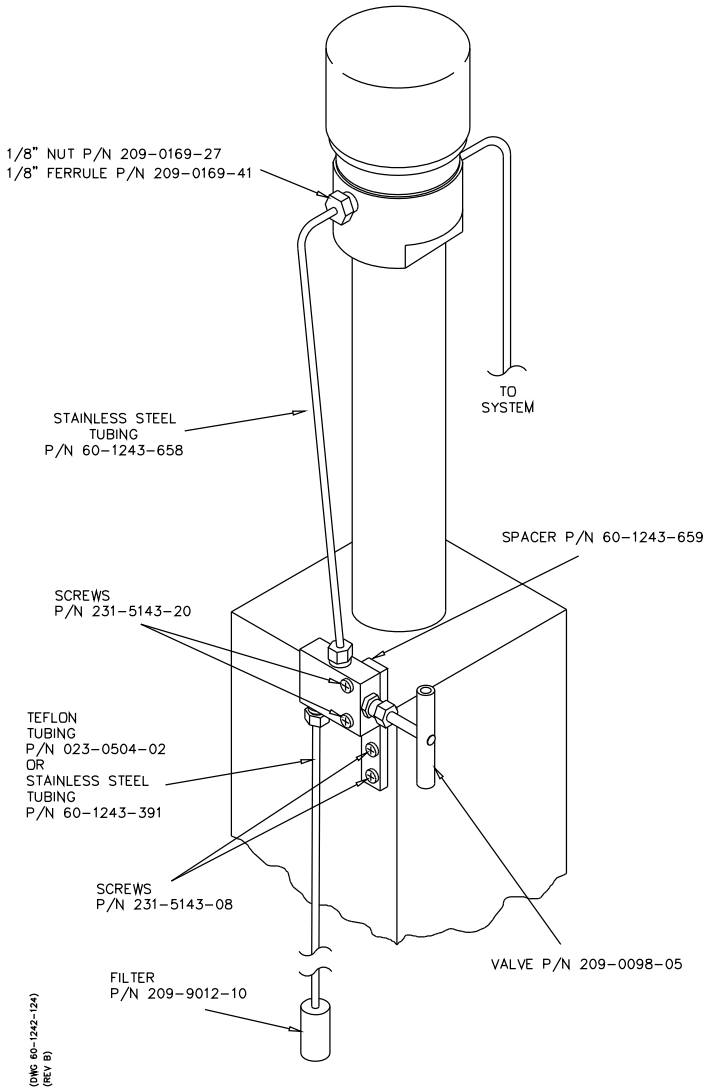
The package also contains all the tubing and hardware necessary for valve installation.

1. To attach the 2-way valve to the pump housing, use the valve (see Figure 2A-4): spacer block and screws provided.
2. Then connect the pre-bent 1/8" stainless steel tubing from the valve to the pump inlet. Use the 1/8" nut and ferrule to connect the tubing at the inlet and the valve fittings to connect the tubing at the valve.
3. Then connect the 1.5 m Teflon refill tubing (with the filter) to the port of the 2-way valve, using the valve fittings.

Figure 2A-4 Refill kit installation

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.



2A.4.2 Outlet Valve Package

The optional outlet valve package is part number 68-1247-078, Table 2A-2.

Table 2A-2 Outlet Valve Package (68-1247-078)

Qty.	Part Number	Description
1	60-1243-659	Valve spacer
1	60-1243-322	5.1 cm - 0.069 ID stainless steel tubing
1	209-0169-27	1/8" nut
1	209-0162-00	1/8" - 1/16" union
1	209-0098-05	2-way straight valve
1	209-0169-48	Zero volume, gold plated 1/8" ferrule
1	60-1243-658	1/8" OD - 0.069 ID stainless steel tubing
1	60-1243-320	1/16" OD - 0.02 ID × 0.9 m stainless steel tubing
Appropriate screws and washers also included.		

To install the outlet valve package (Figure 2A-5*)*

1. Attach the 2-way valve using the spacer block and panhead screws provided in the refill kit.
2. Connect the pre-bent 1/8" OD length of stainless steel tubing to the outlet port on the pump using the 1/8" nut and 1/8" ferrule. Connect the other end to the top port on the valve using the valve fitting.

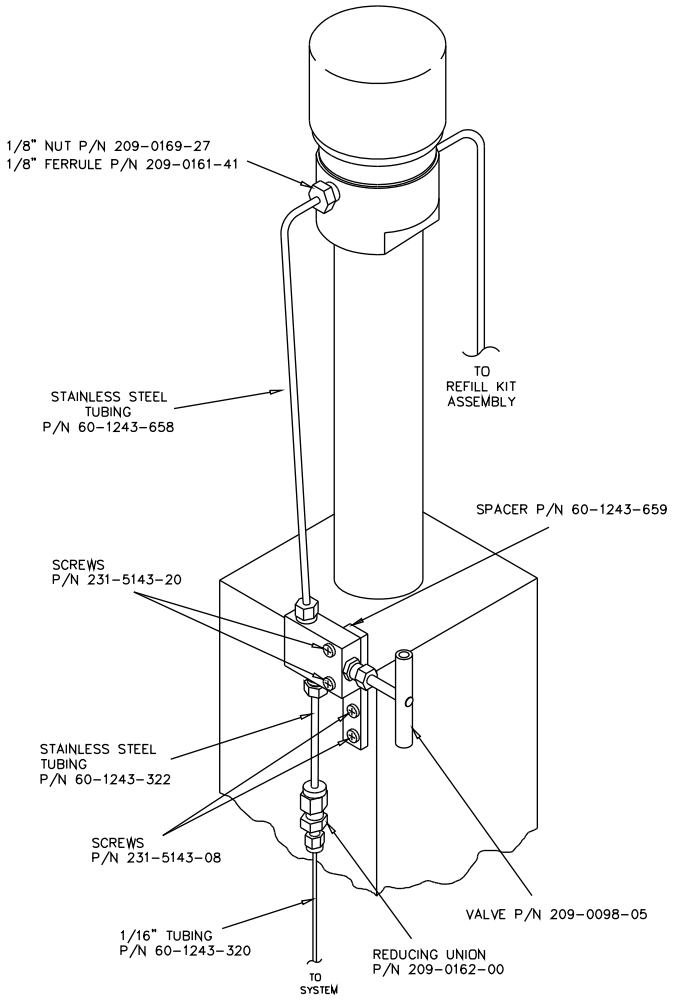
> ☑ ***Note***
>
> When nuts are torqued to the cylinder cap ports, the pressure reading may be affected. If the pressure no longer reads zero, push pressure zero key on the front panel of the controller to readjust.

3. Use the valve fittings to attach the 5.1 cm length of 1/8" OD stainless steel tubing to the port of the 2-way valve.
4. Connect the reducing union, (P/N 209-0162-00) to this 5.1 cm tubing.
5. Connect the 0.9 m length of 1/16" tubing between the reducing union and your apparatus. Cut to the desired length.

Figure 2A-5 Outlet valve package connection

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.



2A.4.3 In-Line Filter Package

The optional in-line filter package (P/N 68-1247-011) should be used when it is important to filter flow exiting the pump. This package (Table 2A-3) contains a 0.5 µm filter and 1⁄16" tubing.

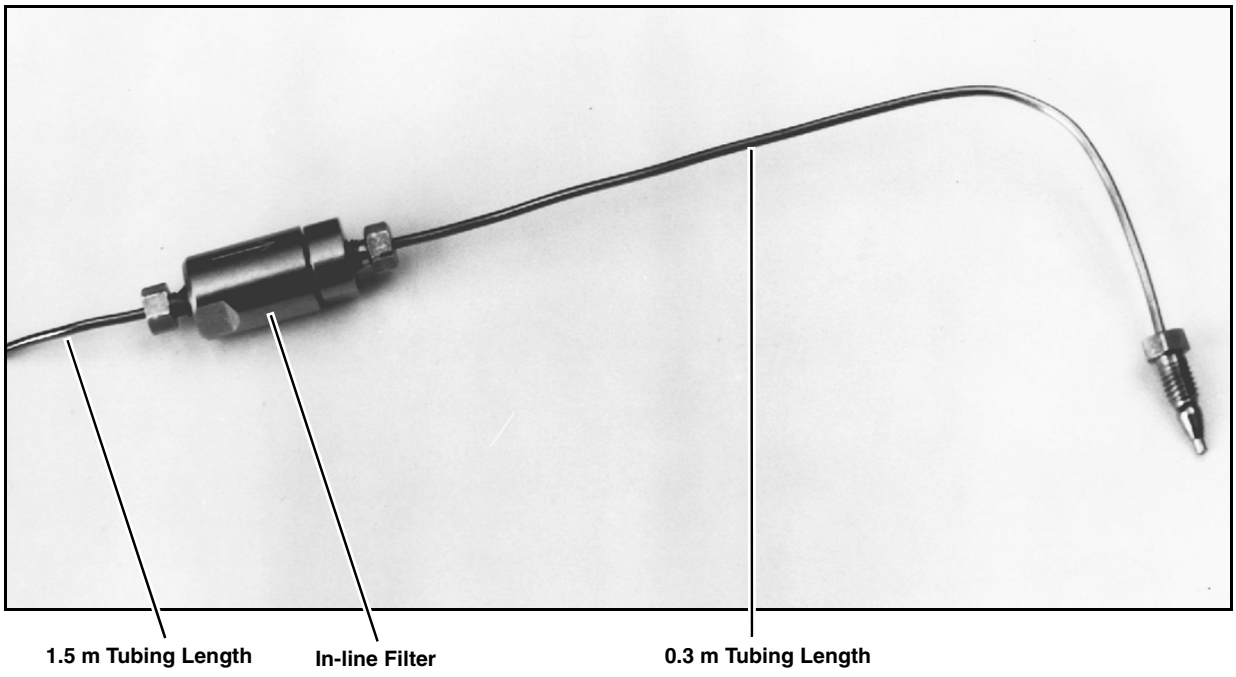
Table 2A-3 Optional in-line Filter Package (68-1247-011)

Qty.	Part Number	Description
1	60-1243-231	1.5 m stainless steel tubing, 1⁄16" OD × 0.020" ID
1	60-1243-232	0.3 m stainless steel tubing, 1⁄16" OD × 0.020" ID
1	209-9012-17	In-line solvent filter with replacement frit, 0.5 micron filter
5	209-0094-07	Zero volume, 1⁄16" valve nut
5	209-0094-08	Zero volume, 1⁄16" valve ferrule

To install the in-line filter package (Figure 2A-6*)*

1. Attach the reducing adapter, included with your pump accessory package to the pump outlet using the nut and ferrule provided. Or, connect to the reducing union of the outlet valve package.
2. Attach the 1⁄16" - 1.5 m length of tubing to the reducing adapter. Cut to the desired length.
3. Then attach the in-line filter to the end of the tubing. The flow direction is indicated on the filter body.
4. Connect the remaining 0.3 m length of tubing between the in-line filter and the receiving device. Cut to the desired length.

Figure 2A-6 In-line filter package



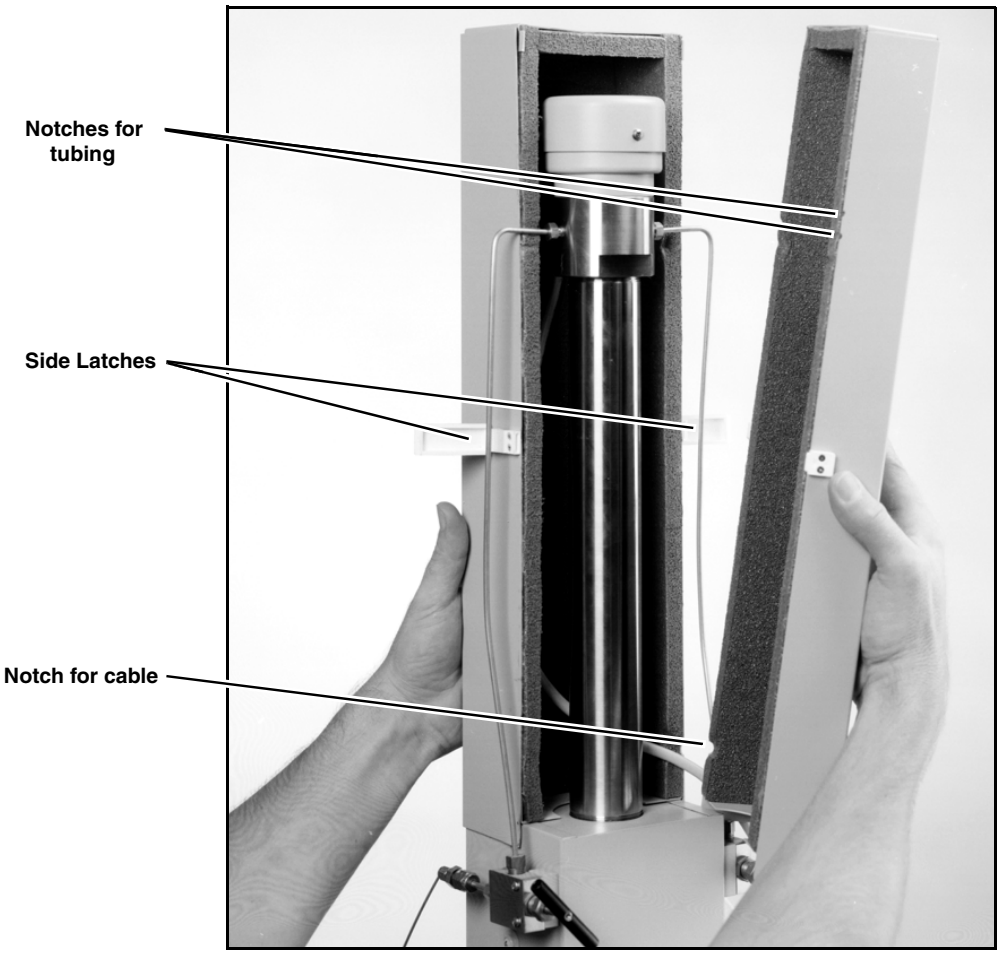
2A.5 Temperature and Pressure Controls

2A.5.1 Cylinder Insulating Cover

An optional insulation cover (Isco P/N 68-1247-081) is available to reduce noise (due to temperature fluctuations) and also improve pump performance at flow rates under 500 µl/min.

The cover consists of two pieces which fit over the cylinder, as shown in Figure 2A-7.

Figure 2A-7 Cylinder insulation cover



Notches in the cover provide openings for the inlet and outlet tubing and for the cable to the pressure transducer.

To install the cylinder insulating cover (Figure 2A-7*)*

1. Install the back cover.
2. Route the cable around tubing through the appropriate tabs.
3. Install the front cover and secure the side latches.

2A.5.2 Cooling/Heating Jacket

An optional cylinder temperature jacket (68-1247-047) is available for use in maintaining cylinder temperatures (–50 to 100°C) by circulating liquids, such as water or water/ethylene glycol solution through the ¼" upper and lower hose connectors.

To install the cooling / heating jacket (Figure 2A-8*)*

The jacket can be used with a circulating temperature-controlled bath to keep the fluid inside the pump at a constant temperature. This may be necessary when operating at very low flow rates (below 100 µl/min), where temperature fluctuation can cause flow variations.

Removing the pump cylinder

1. Empty the cylinder.

☑ Note

Be sure the piston is left fully extended.

2. Turn the pump's mains power switch OFF or disconnect the power cord.
3. Remove the pump front cover by loosening the four cover screws (two, located on each side of the pump).
4. Loosen the cylinder lock screw (a ¼"-20 set screw) in the front side of the cylinder housing.
5. Disconnect the pump pressure transducer cable from the pump and remove the inlet and outlet tubing.
6. Unscrew the cylinder from the cylinder housing.

☑ Note

It may be necessary to use a tubing strap wrench or Isco wrenches package P/N 68-1247-067 to unscrew the cylinder without marring its outer surface.

7. Lift the cylinder up and off the piston and push rod.

Figure 2A-8 Cooling/Heating jacket installed

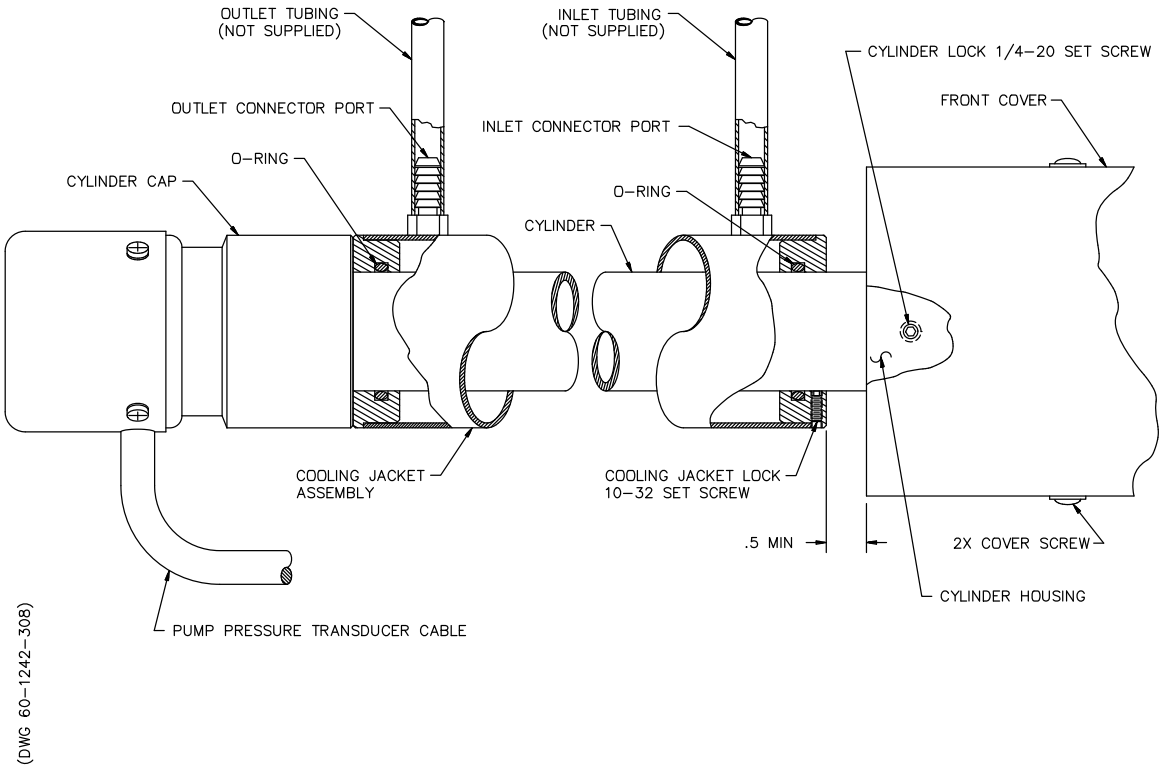


Table 2A-4 Cooling/Heating Jacket Package (part #68-1247-047 for 100HL and 260HL) (part #68-1247-057 for 500HL)

Qty.	Part Number	Description
1	60-1248-053 60-1248-099*	Cooling/heating jacket assembly
1	490-0031-54	Key 3⁄32" socket
1	60-1242-183	Installation procedure
2	202-2062-23 202-2062-11*	O-ring
*For 500HL parts.		

To install the cooling jacket

1. Install the O-rings in the grooves of the cooling jacket.
2. Lubricate the O-rings with soapy water or a light oil to ease assembly of the cooling jacket onto the cylinder.
3. Slide the cooling jacket onto the cylinder using a twisting motion.

☑ *Note*

It is important that the cooling jacket be installed with the locking set screw away from the cylinder cap.

4. Be careful not to damage the O-rings when pushing them over the threads of the cylinder.

Reassembling the pump

1. Place the cylinder/cooling jacket assembly over the piston and push rod assembly.
2. Screw the assembly into the cylinder housing until the cylinder no longer turns. This indicates that it is snug against the piston.
3. Unscrew the cylinder a minimum of ½ turn.
4. Line the inlet and outlet cylinder cap ports up as you had them before. Turn the cooling jacket ports to the desired location and lock the cooling jacket to the cylinder by tightening the cooling jacket lock set screw.
5. Lock the cylinder by tightening the cylinder locking screw.
6. Replace the front cover and adjust both covers so they are flush with the cylinder housing.
7. Reinstall tubing.
8. Reconnect the pump pressure transducer cable.

Anytime you adjust fittings on the cylinder cap you should re-zero your pump's pressure transducer. See section 3.4.5. The pump's pressure transducer is a very sensitive strain gage which can be offset as much as 17.2 bar by tightening fittings.

2A.5.3 Back Pressure Regulation

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE THE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

Two back pressure regulators are available from Isco: a 7 bar (P/N 209-9012-22) or a 5 bar back pressure regulator (P/N 209-9012-21). Both regulators reduce flow noise and improve pump performance at pressures less than 3.5 bar. Fittings to connect the tubing to the regulators are supplied.

To install the back pressure regulator

1. Note the arrow on the regulator indicating the fluid direction.

2. Connect your tubing (not supplied) between the pump outlet and the regulator using the supplied fittings, see Figure 2A-9.

Figure 2A-9 Back pressure regulator

2A.6 Nitrogen Purge

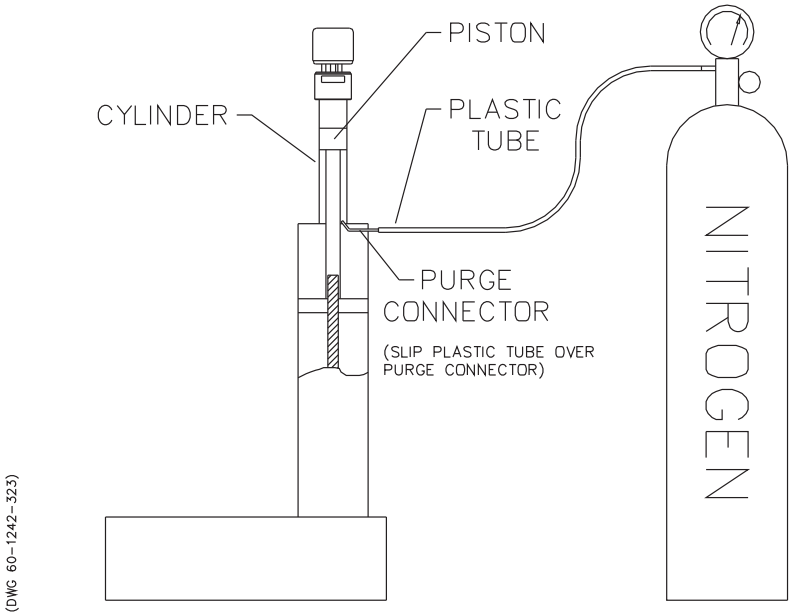
A thin film of liquid will wet the inside of the cylinder each time the piston travels up the cylinder. Corrosive liquids drying in the air can cause the cylinder to corrode. This corrosion occurs at varying rates based on the liquids and pumping conditions being employed. The lowest flow rate engenders the most corrosive pumping environment, as the deposited film has the longest time to corrode the inside of the cylinder wall.

The 100HL or 260HL pump is equipped with a purge connector (Figure 2A-10). The purge connector enables the pump cylinder beneath the piston to be purged with nitrogen which inhibits cylinder corrosion and may increase the useful cylinder life. Figure 2A-10 shows a typical purge connection to the purge tube on the back of the pump.

To install the nitrogen (Figure 2A-10*)*

1. Attach gas supply by slipping the plastic tube over the purge connector, see Figure 2A-10.

Figure 2A-10 Purge connector installation



2A.7 Optional Accessories

Table 2A-5 presents the optional accessories available for use with the 100HL and 260HL pumps.

Table 2A-5 Optional Accessories

Software		
Part Number	**Description**	
Call Isco	LabView Virtual Instrument Drivers – interfaces HL Series Pumps with LabView Software	
SM-1	High accuracy transducer. Contact factory for specifications.	
Other Accessories		
209-9012-21	5 bar back pressure regulator	
209-9012-22	7 bar back pressure regulator	
Tubing		
60-1155-014	3 m Teflon tubing, 1/8" OD × 0.022" ID	
004-7300-21	Stainless steel 304 tubing, 1/16" OD × 0.020" ID	
004-7302-22	Stainless steel 304 tubing, 1/8" OD × 0.069" ID	
004-7300-23	Stainless steel 304 tubing, 1/16" OD × 0.007" ID	
004-7462-51	Stainless steel 316 tubing, 1/16" OD × 0.009" ID	
Extension Cables		
68-1020-210	Pump/Controller extension cable, 3 m.	
68-1020-214	Pump/Controller extension cable, 15 m.	
Inlet/Outlet Fittings		
209-0166-80	1/8" SST plug	
209-0162-00	1/8" - 1/16" tubing reducing union	
209-0169-42	1/8" - 1/16" internal reducer	
In-Line Filter Package (P/N 68-1247-011)		
Qty.	**Part Number**	**Description**
1	60-1243-231	1.5 m - Stainless steel tubing, 1/16" OD × 0.020" ID
1	60-1243-232	0.3 m- Stainless steel tubing, 1/16" OD × 0.020" ID
1	209-9012-17	In-line solvent filter with replacement frit, 0.5 micron filter
5	209-0094-02	Zero volume, 1/16" nut
5	209-0094-03	Zero volume, 1/16" ferrule

Table 2A-7 Optional Accessories, continued		
Outlet Valve Package (P/N 68-1247-078)		
1	209-0098-05	2-way thru valve, 1/8" OD, bracket mounted
Appropriate Stainless steel tubing, tube fittings, and unions also included.		
Cylinder Insulating Cover (P/N 68-1247-081)		
Cooling/Heating Jacket Package (P/N 68-1247-047)		
1	60-1248-053	Cooling/heating jacket assembly
1	490-0031-54	3/32" socket screw key
1	60-1242-183	Installation procedure
2	202-2062-23	O-ring, 1.609" ID
Pump Refill Kit (P/N 68-1247-077)		
1	60-1243-659	Valve spacer
1	209-0098-05	2-way thru valve, 1/8" OD, bracket mounted
1	023-0504-02	1.5 m - 0.065" ID Teflon tubing
1	60-1243-658	Inlet valve tubing, 1/8" OD
1	209-0161-66	Nut 1/8"
1	209-0161-67	Ferrule 1/8" tubing
1	209-9012-10	10 micron filter
1	60-1243-391	1.5 m coiled - Stainless steel tubing, 0.125" OD × 0.069" ID
Appropriate screws and washers also included.		

Table 2A-7 Optional Accessories, continued		
Continuous Flow Check Valve Package (P/N 68-1247-059)		
4	60-2253-240	Check valve housing, analytical standard inlet
4	60-3864-010	Check valve cartridge
2	60-1243-517	Double check valve housing
Appropriate nuts, ferrules, tubing, tube reducers, and filters also included.		
Continuous Flow Air Driven Valve Package (P/N 68-1247-061)		
2	69-1243-572	3-way valve
1	69-1243-574	Air actuator
Appropriate nuts, ferrules, tubing, tube reducers, and filters also included.		
Analog Output Package (P/N 68-1247-070)		
1	60-1244-262	Analog output circuit board assembly
1	60-1242-277	Assembly instruction procedure
1	232-1140-00	6-32 Stainless steel hex nut
1	149-9004-05	Jack socket assembly

HL Series Syringe Pumps: Model 500HL

Section 2B Liquid System Connection & Accessories

2B.1 Introduction

⚠ WARNING

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 260 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

This section discusses 500HL liquid system connections, in general, and details the accessory package installation. It also covers the installation of fluid connection accessories, temperature and pressure control accessories, optional kits and attachments, and software options.

If you are familiar with syringe pumps, you may wish to skip over the general information and helpful tips presented in section 2B.3, *Liquid System Connections*, and proceed directly to your 500HL package installation instructions. Use the following reference chart to locate the desired section.

☑ *Note*

When operating the pump at flow rates at or below 100 µl/min, it is strongly suggested that a cylinder insulating cover be installed. See section 2B.5.1.

Fluid Connection Accessories (section 2B.4):

Refill kit, 2B.4.1

Temperature and Pressure Controls (section 2B.5):

Cylinder insulating cover, 2B.5.1
Cooling/heating jacket, 2B.5.2

Nitrogen Purge (section 2B.6)

Optional Accessories (section 2B.7)

2A.2 Fluids Certified for Isco HL Pumps

⚠ WARNING

Pumping fluids that are not compatible with the HL Series Pump may damage critical components, resulting in property damage, personal injury, or even death. Users who pump fluids other than those listed below do so at their own risk.

The fluid-contacting materials within the HL Series Syringe Pump have been tested and certified to be compatible with the following fluids:

• ethane	• ethylene	• propane	• propylene
• butane	• butadiene	• hexane	• gasoline
• diesel fuel	• jet fuel	• ammonia	• methanol
• isopropanol	• acetone	• acetonitrile	• heptane
• benzene	• ethylbenzene	• methane	

Consult with Isco before using any chemical not listed above.

2B.3 Liquid System Connections

The following section provides general information concerning the 500HL syringe pump, some tips about liquid connections and information about tubing and tubing cutting procedures. The accessory package is also discussed.

2B.3.1 Ports

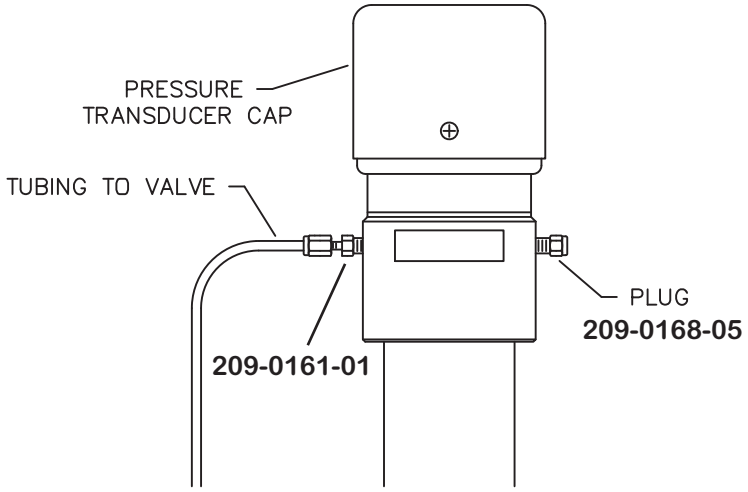
There are two ports in the cylinder cap. The 500HL ports come standard with $\frac{1}{8}$" pipe thread fittings.

Either port can serve as the inlet or outlet. As shown in Figure 2B-1, you may plug one port and use a single port as both the inlet and outlet.

Figure 2B-1 Liquid system plumbing connections for the 500HL pump

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 260 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.



2B.3.2 500HL Installation Tips

- Be sure to keep the tubing as straight as possible at the end, as this will make it easier to install the ferrules.
- Be sure to cut the ends of the tubing squarely.
- Don't leave burrs on the ends of the tubing.
- When installing ferrules on the tubing, be sure the tubing extends beyond the ferrule to allow for proper crimping.
- If the connection is leaking, retighten fittings.
- Push the tubing completely into the port before tightening the nut.
- When connections are made to the cylinder cap, the pressure reading may be affected. If the pressure no longer reads zero, push the pressure zero key on the controller front panel.

2B.3.3 Cutting Tubing

To prevent possible problems, it is important to squarely cut the tubing. Square ends will be easier to insert through the ferrule and will lower the dead volume.

It is recommended that electrochemically machined steel tubing be used throughout the plumbing system. Electrochemically machined tubing has flat, burr-free ends for minimum dead volumes and is free of cutting residues. Pre-cut, electrochemically machined tubing is available through many chromatographic supply distributors in assorted lengths.

A somewhat less desirable alternative is to purchase a tubing cutter designed to handle steel tubing. For quick fixes, the tubing may also be cut by hand with the following procedure. A jewelers file, goggles, and two pairs of pliers are necessary for this operation.

To cut the tubing by hand

1. Wear goggles. Using a fine jewelers file, score the tubing around its entire circumference.
2. Secure the tubing with pliers on each side of the score line, leaving approximately 1⁄16" between each set of pliers and the score line. Care must be taken not to squeeze the tubing too tightly, as that will flatten or deform the exterior of the tubing.
3. With the pliers, bend the tubing back and forth to cause cracking at the score line. The bending should be done in two places to reduce the chance of squashing the tubing.
4. It may be necessary to deburr the outside of the tubing ends with the file. Make sure the tubing ends are clean and the inner bore is clear before installing the cut tube.

> ☑ ***Note***
>
> It is often impossible to remove a burr that blocks the inner bore.

2B.3.4 Accessory Package

The 500HL accessory package (P/N 68-1249-016) contains the items listed in Table 2B-1. These are included for your convenience, to aid in operation of your pump.

Table 2B-1 500HL Accessory Package (68-1269-001)

Qty.	Part Number	Description
2	202-9093-56	Heavy duty graphite filled seal
1	60-1244-271	Lubrication kit
1	490-0031-25	1⁄8" short arm, socket screw key
1	029-0712-02	0.9 m - 1⁄4" ID Tygon R-1000 tubing

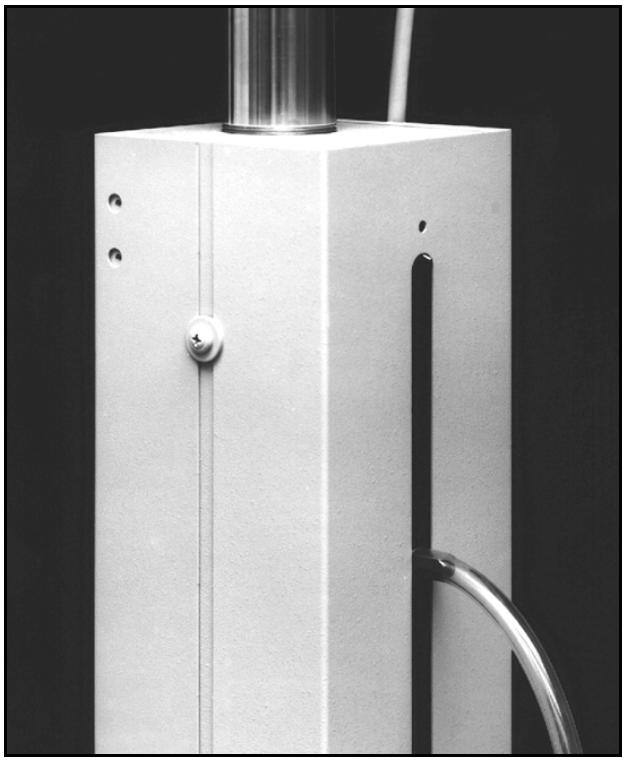
2B.3.5 Drain Tube

The overflow outlet on the pump cylinder provides a means of draining fluid from seal leakage. Use the 1⁄4" ID flexible tubing included with the accessory package, to divert the leakage away from the pump. To install the drain tube simply place one end of the tubing over the end of drip pan outlet, shown in Figure 2B-2.

☑ Note

The drain tube shown in this photo may appear slightly different than that on your pump.

Figure 2B-2 Drain tube installation



2B.4 Fluid Connection Accessories

The optional accessories discussed in this section are used to make fluid connections from the 500HL pump to another apparatus.

When making fluid connections, be sure to use the ferrules provided in the connectors. Then push the tubing completely into the connector and finger tighten. Then tighten with a wrench to clamp the ferrules on the tubing.

2B.4.1 Refill Kit

The refill valve package is rated to 689.5 bar. It includes those items necessary to connect to pressurized or non-pressurized refill sources. Table 2B-2 lists the contents of the package. Figure 2B-3 illustrates the installation of the package.

To install the refill kit

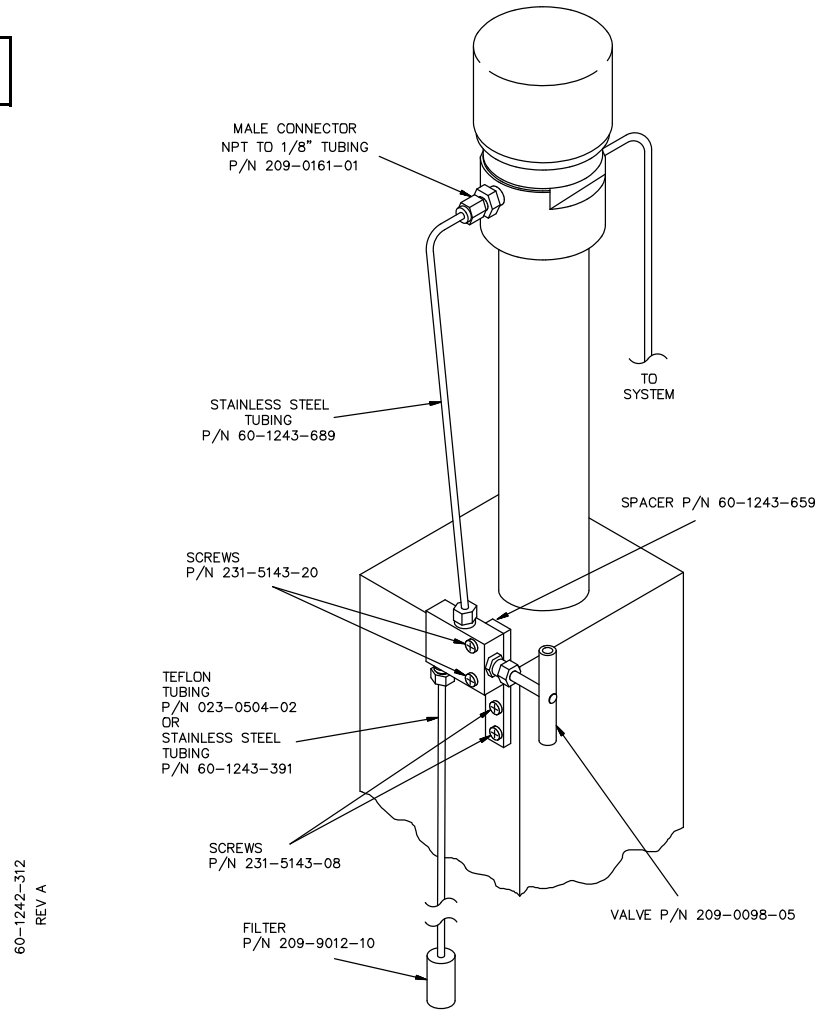
1. Attach the valve to the pump tower using the valve spacer and screws provided.
2. Screw the male adapter (P/N 209-0161-01) into the inlet port of the pump.
3. Connect the pre-bent tubing from the valve to the male adapter, using the nuts and ferrules supplied.

Table 2B-2 Refill Kit Package (68-1247-083)		
Qty.	**Part Number**	**Description**
1	209-0098-05	2-way valve
1	60-1243-689	Stainless steel tubing 1/8" OD, 0.069" ID
1	023-0504-02	1.5 m - 0.125" OD × 0.065" ID Teflon tubing
1	209-9012-10	10 micron filter
1	209-0161-01	Male connector NPT to 1/8" tubing
1	60-1243-659	Valve spacer
1	60-1243-391	1.5 m - 0.125" OD × 0.069" ID stainless steel tubing
1	209-0161-66	1/8" nut
1	209-0161-67	1/8" ferrule
Appropriate screws and washers also included.		

Figure 2B-3 Refill kit installation on the 500HL pump

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 260 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.



4. Then connect the Teflon tubing (with the filter) to the bottom port of the valve, using the valve fittings,

   or,

   When connecting to pressurized sources, use the stainless steel tubing without a filter. Due to the wide variety of pressure sources, fittings to connect to the pressurized source are not provided.

2B.4.2 Outlet Valve Package

The outlet valve package is rated to 689.5 bar. It includes those items necessary to connect a shut-off valve between the pump and your system process. Table 2B-3 lists the contents of the package. Figure 2B-4 illustrates the installation.

To install outlet valve package

1. Attach the valve to the pump tower, using the valve spacer and screws provided.
2. Screw the male adapter (P/N 209-0161-01) into the pump outlet.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 260 BAR. PLEASE UTILIZE THE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

3. Connect the pre-bent tubing from the male adapter to the valve, using the nuts and ferrules provided.
4. Connect the 1.5 m piece of stainless steel tubing to the bottom port of the valve, using the fittings provided. This piece of tubing should be cut to the proper length for connection to your process system. Due to the wide variety of applications this pump is used for, fittings to connect this tubing to your system are not provided.

2B.5 Temperature and Pressure Controls

2B.5.1 Cylinder Insulating Cover

An optional insulation cover (P/N 68-1247-085) is available to reduce flow noise due to temperature fluctuations and also improve pump performance at flow rates under 500 µl/min.

The cover consists of two pieces which fit over the cylinder, as shown in Figure 2B-5.

Notches in the cover provide openings for the inlet and outlet tubing and for the cable to the pressure transducer.

To install the cylinder insulating cover

1. Install the back cover.
2. Route the cable around the tubing through the appropriate tabs.
3. Install the front cover and secure the side latches.

Figure 2B-4 500HL pump outlet valve package installation

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 260 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

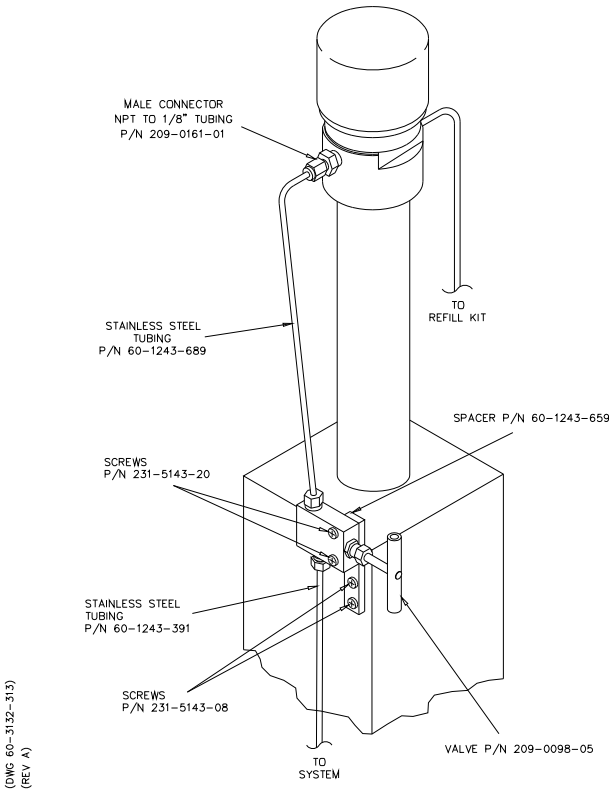
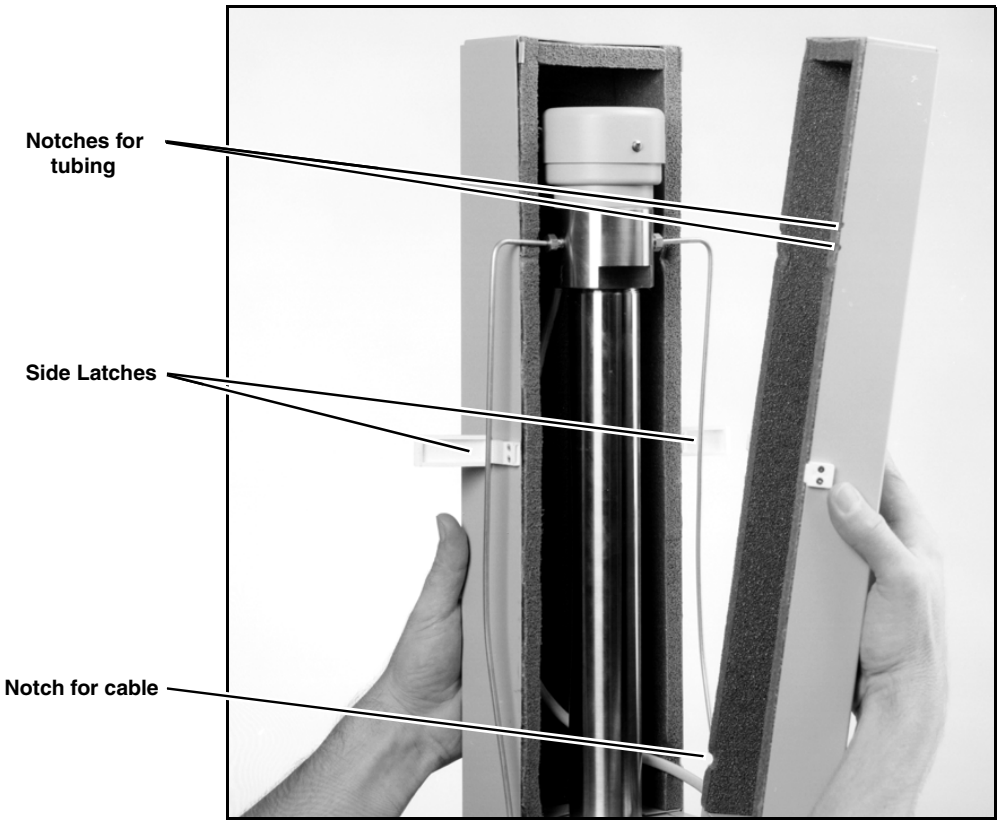


Figure 2B-5 500HL cylinder insulation cover



2B.5.2 Cooling/Heating Jacket

An optional cylinder temperature jacket (P/N 68-1247-057) is available for use in maintaining cylinder temperatures (–50 to 100°C) by circulating liquids, such as water or water/ethylene glycol solution, through the hose connectors.

See section 2A.5.2 for installation instructions.

2B.6 Nitrogen Purge

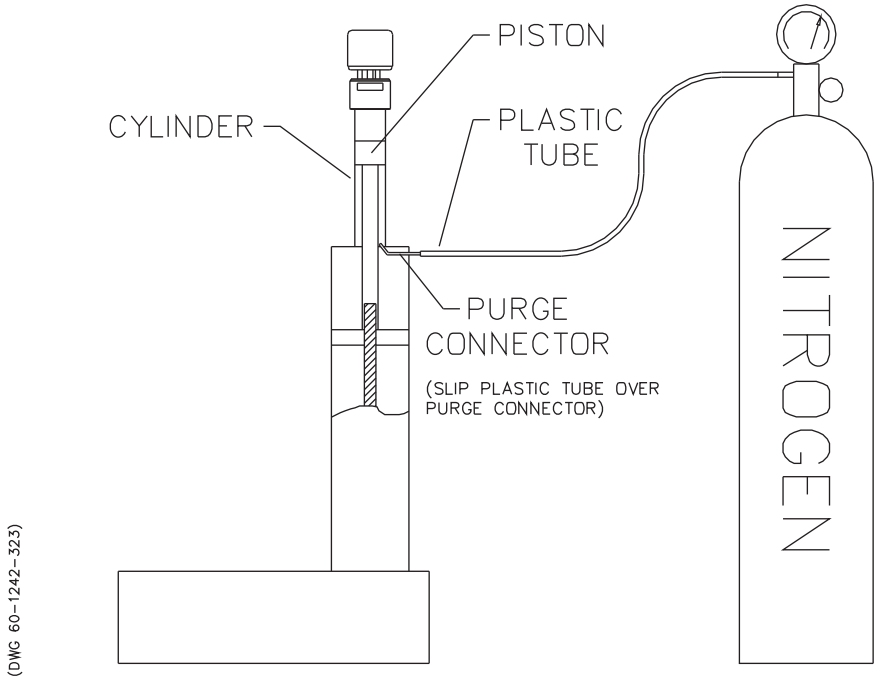
A thin film of liquid will wet the inside of the cylinder each time the piston travels up the cylinder. Corrosive liquids drying in the air can cause the cylinder to corrode. This corrosion occurs at varying rates, based on the liquids and pumping conditions being employed. The lowest flow rate engenders the most corrosive pumping environment, as the deposited film has the longest time to corrode the inside of the cylinder wall.

The 500HL pump is equipped with a purge connector (Figure 2B-6). The purge connector enables the pump cylinder beneath the piston to be purged with nitrogen, which inhibits cylinder corrosion and may increase the useful cylinder life. Figure 2B-6 shows a typical purge connection to the purge tube on the back of the pump.

To install the nitrogen purge

1. Attach gas supply by slipping the plastic tube over the purge connector, see Figure 2B-6.

Figure 2B-6 Purge connector installation



2B.7 500HL Optional Accessories

The following list (P/N 60-1242-176) presents the optional accessories available for use with the 500HL pump.

Table 2B-3 500HL Optional Accessories

Outlet Valve Package (P/N 68-1247-082)		
Qty.	**Part Number**	**Description**
1	60-1243-659	Valve spacer
1	209-0098-05	2-way valve
1	60-1243-689	Stainless steel tubing 1/8" OD, 0.069" ID
1	209-0161-01	Male connector, NPT to 1/8"
1	60-1243-391	Stainless steel tubing 1/8" OD, 0.069" ID, 1.5 m
Appropriate screws and washers also included.		
Auto-Refill Valve Package (P/N 68-1247-062)		
Cylinder Insulating Cover (P/N 68-1247-085)		
Heating/Cooling Jacket (P/N 68-1247-057)		
Extension Cables		
1	68-1020-210	3 m
1	68-1020-214	15 m
Continuous Flow Air Driven Valve Package (P/N 68-1247-061)		
2	69-1243-572	3-way valve
1	69-1243-574	Air actuator
Appropriate nuts, ferrules, tubing, and tube unions also included.		
Analog Output Package (P/N 68-1247-070)		
1	60-1244-262	Analog output circuit board assembly
1	60-1242-277	Assembly instruction procedure
1	232-1140-00	6-32 Stainless steel hex nut
1	149-9004-05	Jacket socket assembly
1	SM-1	High accuracy transducer. Contact factory for specifications.

HL Series Syringe Pumps: Model 1000HL

Section 2C Liquid System Connection & Accessories

2C.1 Introduction

⚠ WARNING

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 138 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

This section discusses 1000HL liquid system connections, in general.

If you are familiar with syringe pumps, you may wish to skip over the general information and helpful tips presented in section 2C.3, *Liquid System Connections*, and proceed directly to your 1000HL package installation instructions. Use the following reference chart to locate the desired section.

2C.2 Fluids Certified for Isco HL Pumps

⚠ WARNING

Pumping fluids that are not compatible with the HL Series Pump may damage critical components, resulting in property damage, personal injury, or even death. Users who pump fluids other than those listed below do so at their own risk.

The fluid-contacting materials within the HL Series Syringe Pump have been tested and certified to be compatible with the following fluids:

• ethane	• ethylene	• propane	• propylene
• butane	• butadiene	• hexane	• gasoline
• diesel fuel	• jet fuel	• ammonia	• methanol
• isopropanol	• acetone	• acetonitrile	• heptane
• benzene	• ethylbenzene	• methane	

Consult with Isco before using any chemical not listed above.

2C.3 Liquid System Connections

The following section provides general information concerning the 1000HL syringe pump, some tips about liquid connections and information about tubing and tubing cutting procedures.

2B.3.1 Ports

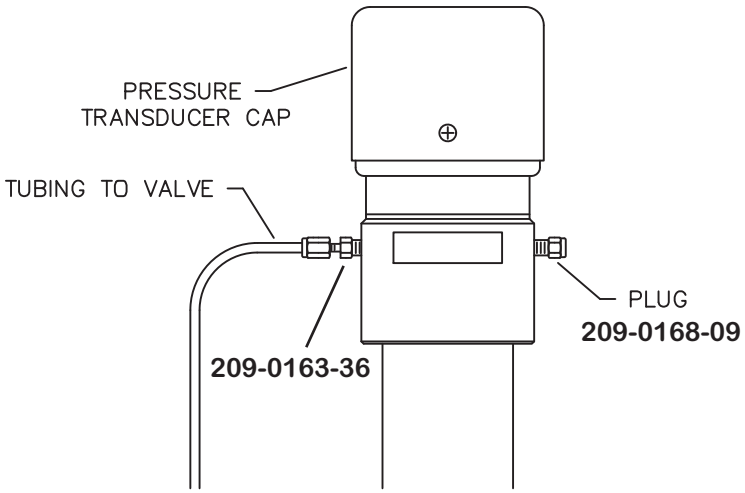
There are two ports in the cylinder cap. The 1000HL ports come standard with $\frac{1}{8}$" pipe thread fittings.

Either port can serve as the inlet or outlet. As shown in Figure 2C.3.2, you may plug one port and use a single port as both the inlet and outlet.

Figure 2B-1 Liquid system plumbing connections for the 1000HL pump

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 260 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.



2C.3.2 1000HL Installation Tips

- Be sure to keep the tubing as straight as possible at the end, as this will make it easier to install the ferrules.
- Be sure to cut the ends of the tubing squarely.
- Don't leave burrs on the ends of the tubing.
- When installing ferrules on the tubing, be sure the tubing extends beyond the ferrule to allow for proper crimping.
- If the connection is leaking, retighten fittings.
- Push the tubing completely into the port before tightening the nut.
- When connections are made to the cylinder cap, the pressure reading may be affected. If the pressure no longer reads zero, push the pressure zero key on the controller front panel.

2C.3.3 Cutting Tubing

To prevent possible problems, it is important to squarely cut the tubing. Square ends will be easier to insert through the ferrule and will lower the dead volume.

It is recommended that electrochemically machined steel tubing be used throughout the plumbing system. Electrochemically machined tubing has flat, burr-free ends for minimum dead volumes and is free of cutting residues. Pre-cut, electrochemically machined tubing is available through many chromatographic supply distributors in assorted lengths.

A somewhat less desirable alternative is to purchase a tubing cutter designed to handle steel tubing. For quick fixes, the tubing may also be cut by hand with the following procedure. A jewelers file, goggles, and two pairs of pliers are necessary for this operation.

To cut the tubing by hand

1. Wear goggles. Using a fine jewelers file, score the tubing around its entire circumference.
2. Secure the tubing with pliers on each side of the score line, leaving approximately 1⁄16" between each set of pliers and the score line. Care must be taken not to squeeze the tubing too tightly, as that will flatten or deform the exterior of the tubing.
3. With the pliers, bend the tubing back and forth to cause cracking at the score line. The bending should be done in two places to reduce the chance of squashing the tubing.
4. It may be necessary to deburr the outside of the tubing ends with the file. Make sure the tubing ends are clean and the inner bore is clear before installing the cut tube.

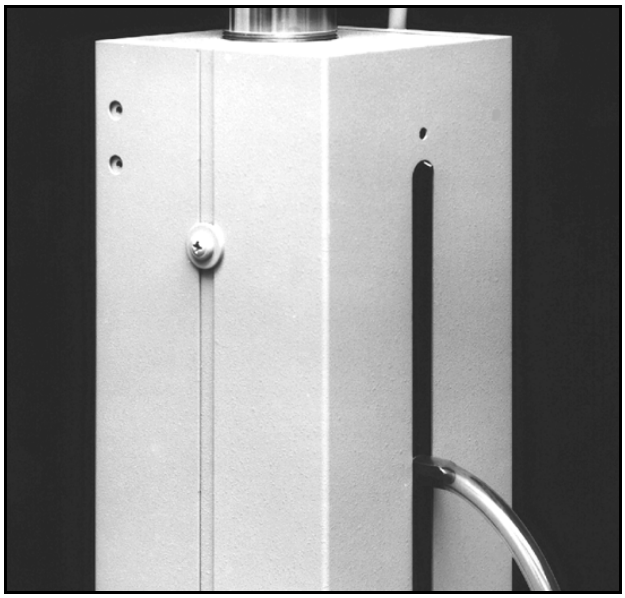
> ☑ ***Note***
>
> It is often impossible to remove a burr that blocks the inner bore.

2C.3.4 Drain Tube

The overflow outlet on the pump cylinder provides a means of draining fluid from seal leakage. Use ¼" ID flexible tubing to divert the leakage away from the pump. To install the drain tube, simply place one end of the tubing over the end of drip pan outlet, shown in Figure 2C-2. You may also drain the fluid away from the pump by connecting to the two ⅛" tubes protruding from the back of the pump.

> ☑ ***Note***
>
> The drain tube shown in Figure 2C-2 may appear slightly different than that on your pump.

Figure 2C-2 Drain tube installation



2C.4 Cylinder Washing and Purging

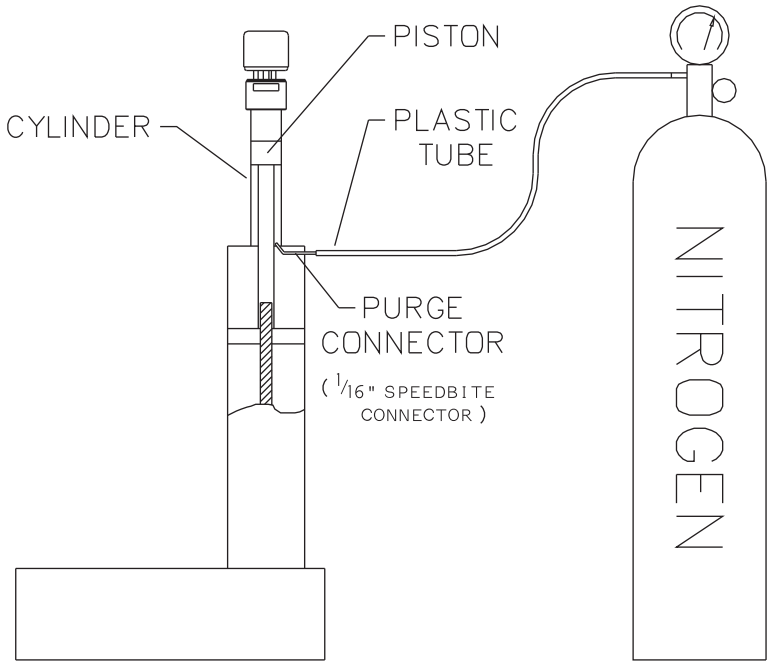
A thin film of liquid will wet the inside of the cylinder each time the piston travels up the cylinder. Corrosive liquids drying in the air can cause the cylinder to corrode. This corrosion occurs at varying rates, based on the liquids and pumping conditions being employed. The lowest flow rate engenders the most corrosive pumping environment, as the deposited film has the longest time to corrode the inside of the cylinder wall.

The 1000HL pump is equipped with a purge connector. The purge connector enables the pump cylinder beneath the piston to be purged with nitrogen, which inhibits cylinder corrosion and may increase the useful cylinder life. Figure 2C-3 shows a typical purge connection to the purge tube on the back of the pump.

To install the nitrogen purge

1. Attach gas supply by connecting tubing to the $\frac{1}{8}$" Speed-Bite connector, located on the back of the pump.

Figure 2C-3 Purge connector installation



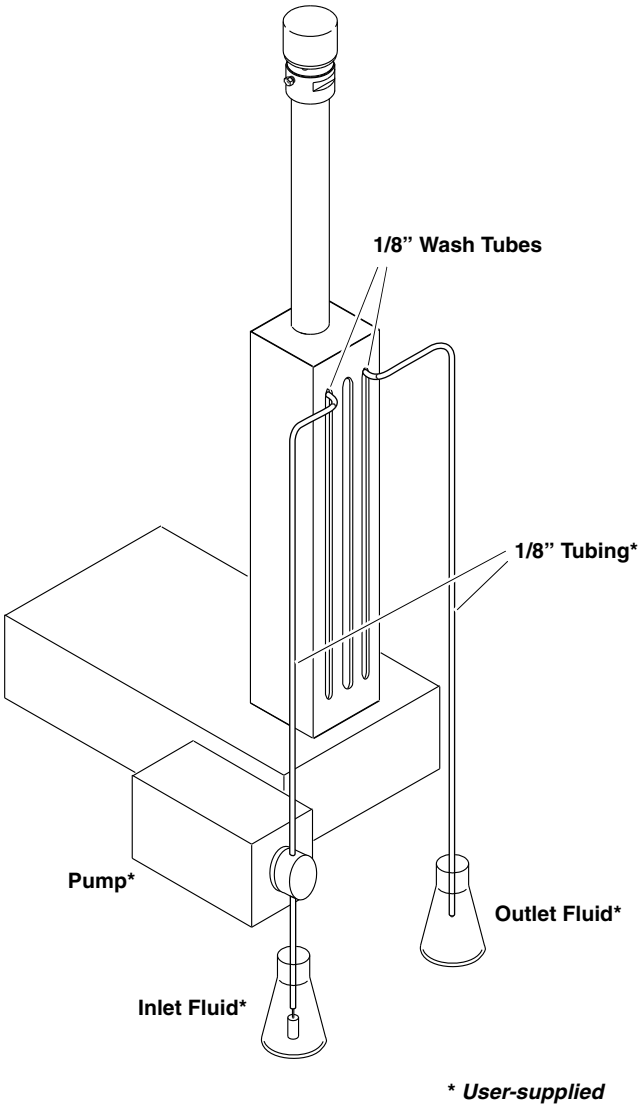
The 1000HL pump is also equipped for cylinder washing. The two 1/8" tubes located on the back of the pump feed the wash gland.

⚠ CAUTION

The pressure in the wash gland and line should NEVER exceed the system pressure. A wash pressure greater than the system pressure may force wash liquid past the pump's main seals and contaminate the delivery fluid.

Typically, a small pump delivers the wash fluid to one of the two 1/8" tubes. The second tube would then be used as an outlet to drain the wash fluid (refer to Figure 2C-4). Select a wash fluid that will best flush the cylinder of any residue left by the pumped fluid, yet will not damage the seals. If the wash pump is configured to recirculate the wash fluid, ensure that you change the wash fluid at regular intervals.

Figure 2C-4 1000HL wash fluid connections



⚠ CAUTION

If the primary pump seal fails, the pressure of the delivery fluid will be exerted on the secondary (wash gland) seal.

HL Series Syringe Pumps

Section 3 Single & Multiple Independent Pump Operation

3.1 Introduction

This section will familiarize you with the HL Series pump controller and describe operating the pump under each of the various modes: constant flow, constant pressure, and refill.

Pump setup and operation is regulated by the HL Series controller. Operating parameters are entered via the keypad on the front panel of the controller. Operating selections are displayed as menu items on the controller screen or are associated with a dedicated key on the controller keypad. Operating modes such as CONST FLOW, CONST PRESS, and REFILL all have such dedicated keys.

⚠ WARNING

UL (Underwriter Laboratories) has certified the HL Series Controller and Pumps on the basis that explosive chemicals or chemicals that could become explosive under pressure are NOT used. The instruments are not explosion proof. Use extreme caution when pumping hazardous fluids.

3.2 General Controller Information

The following information is intended to familiarize you with controller operation. Once you have become familiar with the keypad and the main menu, you will find it easy to direct the pumping operations required for your applications.

Terminology

Mode – The pump mode refers to the type of operation the pump is performing, *e.g.* constant flow or constant pressure.

Screen – The liquid crystal display is referred to in this manual as the LCD, the display, and the screen.

Rates, Units, and Limits – To allow pump operation to be tailored to your application, both the pressure and flow rate units may be set by the user, refer to section 3.3.1, UNITS.

The pump also allows user programmed refill, as well as pumping rates, refer to section 3.3.2, REFILL.

The system protection limits may also be set by the user, refer to section 3.3.5, LIMITS.

> **Note**
>
> **Mistakes** – If you make an incorrect entry, press the CLEAR ENTRY key to delete your last keystroke. If you have entered a programming mode but do not wish to make any changes, press the ENTER key to retain the current setting. If you find yourself locked in a menu, press softkey D under RETURN or EXIT to return to the previous screen.

3.2.1 Display Screens

There are two kinds of screens, programming screens and run screens.

The programming screens are divided into separate menus. These menus are accessed when different features are being programmed.

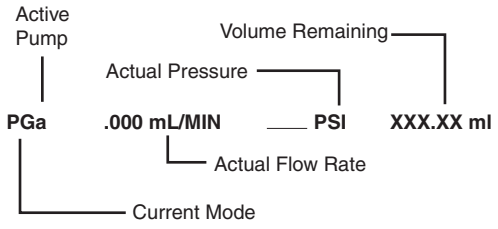
The run screens display the current operating parameters. They are shown once a program has been loaded, and when the pump is running. Refer to section 3.2.2.

3.2.2 The Run Screen

The run screen, which varies depending on the mode you have set, conveniently displays all the pertinent information regarding your pumping operation. There is a great deal of information displayed in a small amount of space. The following paragraphs describe the display line by line.

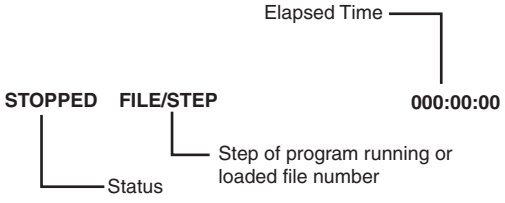
Line One

No matter what mode you are in, the first line of the run screen is always the same.



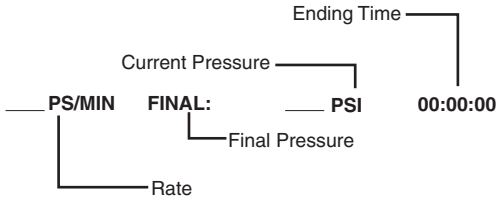
Line Two

The second line varies slightly depending on the operating mode.



Line Three

Line three varies depending on the mode; the rate and units are set by the user, so these will vary depending on your programming requirements. The ending time will always be displayed on this line.



Line Four

Line four varies depending on the mode. The options presented on this line are softkey selectable, *i.e.* you use the softkeys (A - D) located under the screen to choose the option.

3.2.3 Selecting Operating Parameters

There are three ways operating parameters are set from a menu screen, using a softkey or pressing a programming option key on the controller keypad.

Menu Selection

The number keys are used to make menu selections. The menu options will be numbered and demarcated by a period, such as "1. UNITS." Pressing the number 1 will select the UNITS option and cause the units menu to be displayed.

Softkey Selection

The softkey selectable programming options are displayed on the fourth line of the LCD. To select an option, press the softkey, A-D, directly under the option. The parameter will either toggle or be selected when the softkey is pressed.

Keypad Selection

The programming keys are located on the left side of the controller keypad. The pump mode, limits, and refill are all options that may be selected from the keypad.

Value Selection

The number keys are used to enter all numeric values required for pump operation. When a numeric value is required, the controller will usually display a blinking message, prompting you to enter an appropriate value.

3.3 Main Menu Features

The main menu (Figure 3-1) is accessed by pressing the orange MENU key on the pump controller keypad.

Once it is displayed use the number keys to select a menu option. Selecting an option from the main menu displays the programming parameters for that option. These will be presented in menu form. When the main menu is displayed, press softkey A, MORE, to view additional programming options. To return to the run screen press softkey D, RETURN.

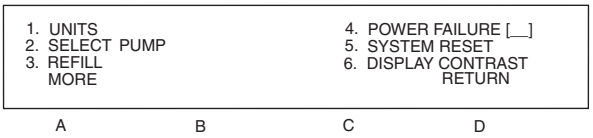


Figure 3-1 Main menu

The following options are available via the main menu, Figure 3-1. Each option is discussed in the separate subsection indicated.

- Units, refer to section 3.3.1.
- Refill, refer to section 3.3.2.
- Power failure, refer to section 3.3.4.
- System reset, refer to section 3.3.5.
- Display contrast, refer to section 3.3.6.
- Serial options, refer to section 3.3.7.
- Status, refer to section 3.3.8.
- External analog control, refer to section 3.3.9.
- Multi-pump mode, refer to 3.3.10.
- Total volume reset, refer to 3.3.11.
- Valve, refer to 3.3.12.

3.3.1 Setting Flow and/or Pressure Units

For your convenience, the controller allows the user to set the displayed units on the pump. See Figure 3-2.

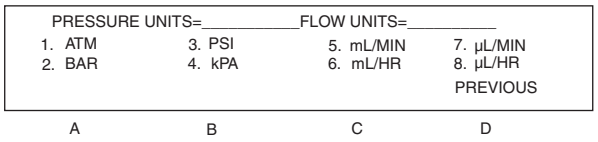


Figure 3-2 Units menu

Setting the units

1. Press the orange MENU key.
2. Press number 1, UNITS.
3. The units menu, Figure 3-2, will be displayed.
4. Use numbers 1-4 to select the pressure units (ATM, BAR, PSI, kPa). Pressing the number associated with the unit will cause it to be displayed on the first line of the screen after PRESSURE UNITS=.
5. Use numbers 5-8 (mL/MIN, mL/HR, µL/MIN, µL/HR) to set the flow rate units. Pressing the number associated with the unit will cause it to be displayed on the first line of the screen after FLOW UNITS=.
6. To exit the UNITS menu, press softkey D, PREVIOUS. This will return you to the main menu screen. Your settings will be saved automatically for all pumps.

3.3.2 Automatic Refill

The refill option allows you to set the refill rate (explained in Section 3.3.3), or have the pump automatically refill when a certain volume is reached, as described below:

To set auto refill volume

1. Press the orange MENU key.
2. Press number 3, REFILL. The auto refill menu, Figure 3-3 will be displayed.

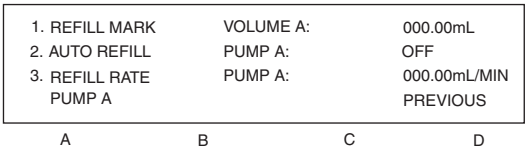


Figure 3-3 Refill menu

> **Note**
>
> If more than one pump is connected to the controller, pump B and pump C will be displayed on the fourth line. To select a pump, press the softkey under the pump designation.

3. Press the number 1 key to set the volume for pump A.
4. The units to the right of the symbol will blink, indicating that you should enter a volume. Use the number keys to enter an appropriate value and then press the ENTER key.

Disable/Enable Auto Refill

The second line will display “OFF” or “ON”, indicating whether or not this feature is enabled for pump A (or the currently selected pump). Press the number 2 key to toggle this feature off and on for each pump, as desired.

If auto refill is ON, then the pump will automatically switch to refill mode when the volume reaches the auto refill mark. After refilling, pumping will resume in the programmed mode. The ACCESSORY outputs, which drive powered valves, will switch in sequence.

To set refill rate

1. Press the number 3 key to set the refill rate for the designated pump. The refill rate can also be changed from the main screen while the pump is refilling.
2. A message will blink on the screen prompting you to enter the selected refill rate.
3. Enter the desired rate using the number keys.
4. Press the ENTER key to save the value.

To exit

To exit the refill menu, press softkey D, PREVIOUS. You will be returned to the main menu; and your selections will be saved.

3.3.3 Set Refill

You can set the refill rate by entering refill mode as explained in this section, or use the volume-based refill option in the main menu as previously explained in Section 3.3.2.

To refill pump

1. Press the blue REFILL key to place the pump in refill mode.
2. If more than one pump is connected to the controller, another menu will be displayed, prompting you to select the pump you wish to refill. Press the appropriate softkey to designate which pump to refill.
3. The message RUNNING will be displayed on the second line of the run screen.

To change the refill rate

1. Press the A softkey, Flow rate. The words ENTER FLOW RATE will flash on the screen.
2. Use the number keys to set the desired refill rate, then press ENTER to save this value.
3. As soon as you press ENTER, the pump will begin using the new rate.

3.3.4 Power Failure [STOP]

This feature allows you to dictate the activity of the pump in the event of a power failure. Use the number 4 key to toggle this feature to [STOP] or [CONT] to automatically resume pumping after power is restored.

> ☑ ***Note***
>
> This option covers all pumps connected to the controller. You cannot dictate the action of an individual pump.

3.3.5 System Reset

This option allows you to completely clear user programmed settings. It will erase all programs and return units and limits to factory settings. If the ZERO PRESS key has been used, the corrected offsets will be lost.

> ☑ ***Note***
>
> This option covers all pumps connected to the controller. You cannot dictate the action of an individual pump.

Press softkey D, DO_NOT, to return to the main menu without resetting your system.

> ☑ ***Note***
>
> Once a system reset has taken place, all programs will be erased. These cannot be recovered. All user-set limits and units will be returned to the factory default settings.

To reset memory

1. Press the orange MENU key.
2. Select number 5. SYSTEM RESET.
3. Press softkey A, CONTINUE.

Hard Reset

A hard reset should only be performed when changing EPROMs for a software upgrade or at the suggestion of the Isco Service Department. Like the system reset, all user programmed settings will be cleared.

> ☑ ***Note***
>
> A hard reset will erase all programs and user defined parameters. These **cannot** be recovered.

To perform a hard reset

1. Remove Power from the pump controller.
2. Press and hold the CLEAR ENTRY key on the front panel keypad.
3. While holding the CLEAR ENTRY key, apply power to the pump controller. Keep the CLEAR ENTRY key pressed for 1 second.
4. Release the key and turn the unit back to STANDBY.
5. Then turn the instrument back ON and execute a system reset (described above).

3.3.6 Display Contrast

The pump conveniently allows you to adjust the screen contrast for your light conditions and viewing angle.

To change the display contrast

1. Press the orange MENU key.
2. Press number 6, DISPLAY CONTRAST. The display contrast menu, Figure 3-4, will be displayed.

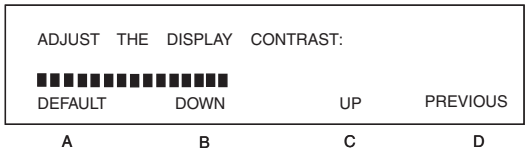


Figure 3-4 Display contrast menu

3. Use softkeys B, DOWN, or C, UP to change the contrast. Raising the contrast [UP] darkens the blue of the writing.

> ☑ ***Note***
>
> Due to differences in manufacture, some displays will not show an obvious variation when the contrast is adjusted. This is normal and should not be considered a malfunction.

3.3.7 Serial Option

The serial option menu allows you to set the baud rate and the unit identification number.

To change the serial options

1. Press the orange MENU key.
2. Press softkey A, MORE.

3. Press number 1, SERIAL OPTION. The serial option menu, Figure 3-5, will be displayed.

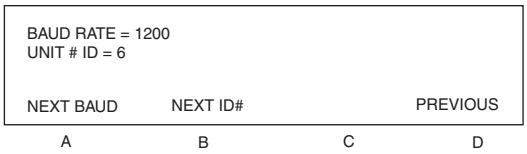


Figure 3-5 Serial option menu

4. Use softkey A, NEXT BAUD, to scroll through the available baud rates. These are: 300, 1200, 2400, 4800, 9600, and 19.2K, 38.4K, 57.6K.
5. Use the softkey B, NEXT ID#, to scroll through the available ID numbers. These are 1-7. Six is the default, as this is the unit identifier for the Isco LabView™ software.

For a complete discussion of serial control, refer to Section 4 in this manual.

3.3.8 Pump Status

This option simply presents the revision of software used by the pump controller and indicates the type of pumps connected to the controller.

> **☑ Note**
> This screen is momentarily displayed automatically each time the pump controller is turned from STANDBY to ON.

To display the status

1. Press the MENU key and then press softkey A, MORE.
2. Press 2 to display the pump status.
3. The first line displays the revision of the software.
4. Lines 2, 3, and 4 display the type of pump connected to the A, B, and C pump connectors, respectively.

3.3.9 External Analog Control

The HL Series syringe pump can be controlled externally by analog voltage in either constant flow or constant pressure mode. The input range is 0–11.5 volts (for all pumps), with a resolution of 5000 increments per volt.

Setting up external control

1. Select the desired operating mode (CONST FLOW or CONST control: PRESS) by pressing the appropriate key on the controller front panel.

   The mode you have selected, along with the current pump will be displayed in the upper left-hand corner of the screen. For example, if you have selected CONST PRESS, CP will be displayed, followed by a lowercase a, b, or c depending on the selected pump.

   To set parameters for a different pump, press softkey D, SELECT PUMP, and choose A for pump A, B for pump B,

etc. Once you have changed pumps, the display will change back to the run screen, automatically.

If you do not wish to select a different pump, press softkey D to return to the run screen.

2. Press MENU, then softkey A for MORE options.
3. Press number key 3 to select EXTERNAL control.
4. Softkey B will toggle the EXTERNAL mode ON or OFF.
5. If you wish to change the full-scale input voltage, press softkey A to SET RANGE. Then enter the new voltage range between 1.000 V and 11.500 V, and press ENTER to store the value. This voltage will correspond to the maximum flow rate or pressure value programmed by the LIMITS key.

$$DV \times \frac{FS}{ML} = \text{input}$$

where:

DV = desired value of pressure or flow rate.
FS = full-scale input range.
ML = max limit of pressure or flow rate
input = external input voltage.

Pressure Example

The maximum pressure desired is 510.2 ATM, (maximum allowed by the MODEL 260HL) with a scale factor of 2.0 volts per 100 ATM. The full-scale input voltage would be:

$$510.2 \text{ ATM} \times \frac{2.00 \text{ V}}{100 \text{ ATM}} = 10.204 \text{ volts}$$

and MAX PRESS should be set to 510.2 ATM.

Maximum Flow Rate Example

The maximum flow rate desired is 25.0 ml/min with a scale factor of 5.0 volts per 20.0 ml/min. The full scale input voltage would be:

$$25.0 \text{ ml/min} \times \frac{5.0 \text{ V}}{20.0 \text{ ml/min}} = 6.250 \text{ volts}$$

and MAX FLOW should be set to 25.0 ml/min.

Wire Connections

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

Two wires are required for analog control. The analog common or ground wire should be connected to the GND terminal under ANALOG INPUT of the ACCESSORY connector on the controller rear panel. The analog control or input wire should be connected to terminal 1 under ANALOG INPUT.

If two pumps are used with the controller, the second analog control or input wire should be connected to terminal 2 under ANALOG INPUT. If three pumps are used with the controller, the third analog control or input wire should be connected to terminal 3 under ANALOG INPUT or to auxiliary (P11) pin 15.

When using one of the multi-pump operation modes, only the ANALOG INPUT terminal 1 needs to be connected.

3.3.10 Multi-Pump

When using multiple pumps, there are four multi-pump operating modes of delivery and an independent mode, including:

- Continuous flow in constant flow mode.
- Continuous flow in constant pressure mode.
- Independent mode.

Continuous Flow (constant flow mode)

An HL Series continuous flow pumping system in constant flow mode, will consist of two syringe pumps and a valve accessory package, all regulated by one controller.

To connect two HL Series pumps for a continuous flow pumping system, you will need a continuous flow check valve package (P/N 68-1247-059) or a continuous flow air driven valve package (P/N 68-1247-058 for 100HL/260HL or 68-1247-061 for 500HL, 1000HL). Installation and operating instructions for this system are located in Section 6.

In this mode the softkeys toggle between the options described in Table 3-1.

Table 3-1 Key functions in the Multi-pump Mode

Key	Display Option	Description
A	NORMAL	Uses a finer (slower) pressure match control when switching from one pump to the other.
	FAST	Uses a coarser (faster) pressure match control when switching from one pump to the other.
B	NORMAL PRESS	Uses pressure matching when switching from one pump to the other
	LOW PRESS	Uses no pressure matching when switching from one pump to the other.

C	DELIVER	Sets the pump into the delivery mode of operation.
	RECEIVE	Sets the pump into the receive mode of operation.
6	MIN/MAX POINTS	Sets the fill and refill marks that are used with both continuous flow modes.

Continuous Flow (constant pressure mode)

An HL Series continuous flow pumping system in constant pressure mode, will consist of two HL Series syringe pumps, and a valve accessory package, all regulated by one controller. To connect two HL Series pumps you will need to use a continuous flow check valve package (P/N 68-1247-059) or a continuous flow air driven valve package (P/N 68-1247-058 for 100HL/260HL or 68-1247-061 for 500HL, 1000HL). Installation and operating instructions for this system are located in Section 6.

In this mode the softkeys toggle between the options described in Table 3-1.

Independent Control of up to Three Pumps

An HL Series syringe pump controller can run three syringe pumps independently of each other in either constant pressure or constant flow mode or any combination of the two. To set up this option use the procedure detailed below.

To designate independent control of multiple pumps

1. Press the orange MENU key.
2. Press softkey A, MORE.
3. Press number 4, MULTI PUMP. The multi-pump menu will then be displayed.
4. Press number 4, INDEPENDENT. The controller will set the pumps to Independent mode. Number 4 will blink, indicating that INDEPENDENT mode is selected.
5. Select the HOLD PRESS or NORMAL mode of operation. Press softkey A to toggle between the two modes.

   HOLD PRESS: After the pump is empty in constant pressure mode, if the outlet pressure rises past the set point the pump will restart and run the system to the set point pressure.

   NORMAL: This feature shuts the pump off if the pumps runs empty in constant pressure mode.

   Once the pumps have been set to this mode, they will operate independently from one another. Each pump will operate at its defined limit and rate. One pump may be operating in constant flow, the other in constant pressure. Independent mode is the default setting for the pump.

   When a command such as stop or refill is pressed, a menu will appear asking you to designate the pump to stop or refill. Only the designated pump will stop, the other pumps will continue in the pumping application you have them set for.

6. Return to the run screen by pressing softkey D three times. Then press softkey D (select pump) to display the select pump screen. This screen will show each pump's pertinent information and allow you to select any pump for programming changes.
7. To select B pump from the select pump screen, press softkey B. This will display the B pump run screen. From here, you can start pump B or change the operating parameters.

3.3.11 Total Volume Reset

This feature will reset the total volume display used in the continuous flow option to zero.

To reset total volume to zero

1. Press the orange MENU key.
2. Press softkey A, MORE.
3. Press number 5, TOTAL VOL RESET.

The volume will then be reset to zero.

3.3.12 Valve

This feature will designate the type of valves (passive, active or electric) being used for the flow operation. (If "active value" or "electric" is selected, the controller will match the pressure more closely before switching delivery pumps.)

To select valve type

1. Press the orange MENU key.
2. Press softkey A, MORE.
3. Press number 6, VALVE. The number for the selected valve type will be blinking.
4. Press the number 1, 2 or 3 key to select a desired option and the number 1, 2, 3 will blink indicating which valve type is selected.
5. To exit this menu, press the softkey D, PREVIOUS, to return to the main menu.

3.3.13 Menu

The Menu gives you access to various functions. The Menu is depicted in Figure 3-6.

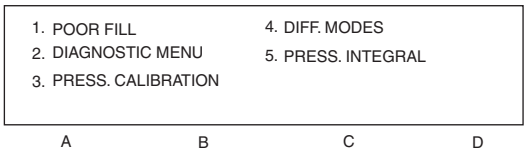


Figure 3-6 Menu

Menu Options

- POOR FILL – In the constant pressure mode, this feature allows you to set a fill point as a percentage of pump volume. If this volume percentage is not reached after a refill and re-pressurization, the system sounds an alarm and stops the pump.

- DIAGNOSTIC MENU – Displays an additional menu containing testing options

  LCD TEST – This feature will cycle the display. Press any key to stop test.

  ANALOG INPUT – This feature will display all the analog input signals on the display.

  MEMORY TEST – This feature will test the memory for errors.

  KEYPAD TEST – This feature will test the keypad. Press "EXIT" to exit.

  MOTOR CONTROL/LIMITS – This feature will test the digital position control system. Press 1, 2, 3 for the pump wanted for test. Press "UP 100" to move the pump's cylinder up 100 counts. Press "DOWN 100" to move the pump's cylinder down 100 counts. Press "EXIT" to exit this function.

  SERIAL TEST – This feature will test the serial channel. Once this feature is active the software will serial send "*******SERIAL TEST XXXX*********" through the serial port. The "REC." message will show any serial input characters on the display.
- PRESS. CALIBRATION – This feature is used for calibration only. If an incorrect number is entered with this feature, the pumps will **NOT** display/run at the correct pressure. Press "CalA" ("Cal", "CalC") and enter the calibration number for the needed pump. Press "Prev" to exit this feature.
- DIFF. MODES – The standard pressure transducer **MUST** be connected to pump for correct operation. This feature allows the use of other analog inputs for pressure input to the pump.

  Press 1, OFF, to turn off this feature.
  Press 1, 0 to 50 ANLG1, to use a 5 volt 50 psi transducer on analog input ANLG1.
  Press 2, Custom ANLG1, to use 5 volt custom pressure transducer on analog input ANLG1.
  Press 4, 500 ANLG2, to use a 5 volt 500 psi pressure transducer on analog input ANLG2.
  Press 5, 5000 ANLG3, to use a 5 volt 5000 psi transducer on analog input ANLG3.
- PRESS. INTEGRAL – This feature lets the user turn on/off the integral function for the pump control.

3.4 Front Panel Keys

In addition to the menu options, certain features are conveniently located on the front panel keyboard. These include:

- LIMITS, 3.4.1
- RAPID PRESS (Rapid Pressure), 3.4.2
- HELP, 3.4.3
- ACCESS CTRL (Accessories Control), 3.4.4

- ZERO PRESS (Zero Pressure), 3.4.5

3.4.1 LIMITS

The controller allows the user to set the minimum and maximum flow rate limits, the minimum and maximum pressure limits, and the maximum rate the pump will run while controlling the pressure in constant pressure mode.

- When using a single controller to operate multiple pumps, you need to select the appropriate pump before setting any pump parameters. The available pumps will be displayed above the softkeys. These selections correspond with the connector that the pump control cable is plugged into on the rear panel of the pump controller. To select a pump, press the softkey under the pump designation. The top line of the screen will indicate the pump which is currently selected.

- The high and low limits you set cannot exceed the pump specifications.

To set the limits

1. Press the LIMITS key on the keypad. To display the Limits menu, Figure 3-7, enter the number of the limit you wish to program using the number keys. This will cause one of five limit setpoint menus to appear, MAX PRESS, MIN PRESS, MAX FLOW, MIN FLOW, or FLOW LIMIT. The MAX PRESS limit setpoint menu is shown in Figure 3-8.

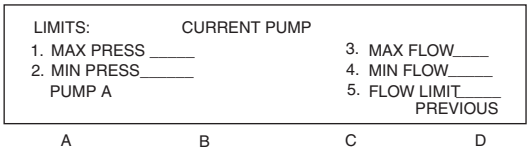


Figure 3-7 Limits menu

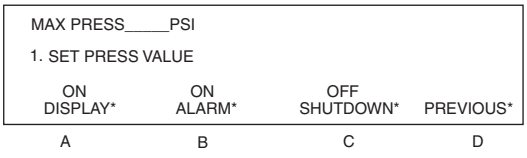


Figure 3-8 Limits setpoint (Max Press) menu

Note

These features are discussed later in this section under Limits Programming Options.

2. Press the number 1 key to set the value. A message will blink on the right side of the screen, prompting you to enter the selected limit.
3. Enter the desired limit setpoint, using the number keys.

4. Press the ENTER key to save the value.

> **Note**
>
> The pump can be set to shut off or not at this limit condition by pressing softkey C under shutdown. This will toggle this option to ON.

5. To exit the limit setpoint menu, press the softkey D, PREVIOUS.
6. Once all the limits have been set, press softkey D, PREVIOUS, to return to the main menu.

Limits programming options

In addition to setting the upper and lower limits, the pump also allows the user to specify whether they want:

- the alarm message displayed
- an alarm to sound when the limit is reached
- the pump to shut down when the limit is reached

These features are set using the softkeys, A-C. Pressing these softkeys toggle the feature on and off. (If you press the softkey once the feature is activated, pressing the softkey again turns the feature off).

> **Note**
>
> The Max Press (maximum pressure) display on and alarm on options cannot be disabled.

Display

When this feature is on and a limit has been exceeded, the pump will automatically flash an over or under limit message on the screen. If you do not wish it to do so, press softkey A once to toggle this to:

OFF
DISPLAY

Alarm

When this feature is on, the pump will automatically beep a warning when a limit has been exceeded. If you wish to disable the beep, press softkey B once. The display should change to:

OFF
ALARM

Shutdown

The pump will, if you wish, shut down [pump stop] when a limit has been exceeded. If you wish to enable this feature, press softkey C once. The display should change to:

ON
SHUTDOWN

Flow rate limit for pressure control

When the pump is controlling pressure (CONSTANT PRESSURE MODE), the flow rate is not set by the operator, and may range up to the maximum flow the pump is capable of. In some cases, it is desired to limit the rate of pumping during system pressurization. This can be done by selecting limit 5, FLOW LIMIT. The FLOW LIMIT value is used as the upper range of flow rate during pressure control. This limit is not the same as the MAX FLOW limit which is a threshold above when the pump is stopped, or an alarm is activated as selected by the operator.

To exit

1. To exit the limits menu, press softkey D, PREVIOUS. You will be returned to the main menu; and your changes will be saved.

3.4.2 RAPID PRESS

This option is available when operating in constant flow mode. It allows rapid pressurization to a stable pressure point and then switches automatically to the constant flow setpoint. This is helpful when you are operating at a low flow rate but wish to rapidly pressurize a solvent.

1. Press the CONST FLOW key, to put the pump in constant flow mode.
2. Press the RAPID PRESS key to start rapid pressurization.
3. The controller will display maximum flow rate and target pressure setting. If these values are correct, press the softkey D to continue rapid pressurization.
4. If you know approximately what the pressure will be when the system is stable, enter this value as a target pressure. Press the softkey A and enter the desired pressure value. This should shorten the time required to stabilize the system pressure.
5. If you would like to limit the maximum flow rate during the rapid pressurization phase, press softkey B and enter the desired flow rate limit.
6. Press the softkey D to continue rapid pressurization.

> ☑ ***Note***
>
> This feature is automatic, *i.e.* the user does not enter a pressure and the RAPID PRESS key is pressed only once.

3.4.3 HELP

When the HELP key is pressed, information regarding the current operation of the pump will be displayed. If you are setting parameters, a short description about the parameters being prompted will be displayed, along with other helpful information. Because most pump programming is self-documented, the HELP messages are limited.

3.4.4 ACC CTRL

The ACC CONTROL key will allow you to manually operate accessories, such as valves, via the Digital Output terminals on the back of the controller.

To set the digital output

1. Press the blue ACC CTRL key. The accessory control menu will be displayed.
2. Use the number keys, 1-4, (1-A INLET, 2-A OUTLET, 3-B INLET, 4-B OUTLET) to toggle the desired valve to either open or closed. (Numbers 1-4 represent digital output terminals 1-4, respectively).
3. Use the number keys, 5-8, to toggle the digital output to either high or low. (Numbers 5-8 represent digital output terminals 5-8, respectively).
4. To exit the accessory control menu, press softkey D, PREVIOUS.

3.4.5 ZERO PRESS

The ZERO PRESSURE key will correct pressure sensor drift. Before pressing the ZERO PRESS key, the pump should be set up and depressurized.

1. Be sure the pump is depressurized with port fittings installed.
2. Press the ZERO PRESS key. A message will ask if you want to zero the pressure; and the current pressure will be displayed on the third line of the display.
3. Press softkey A, pump A, or softkey B, pump B, or softkey C, pump C, to zero the selected pump's pressure.

   or,

   If the pump is not depressurized, press softkey D, DO NOT, to exit the zero pressure operation.

3.5 Operating Modes

The pump has three delivery modes and one refill mode including:

> ☑ ***Note***
>
> When using a single controller to operate multiple pumps independently, you need to select the appropriate pump run screen before selecting an operation mode. To select the appropriate operating pump, press the SELECT PUMP (softkey D) and an intermediate screen will be shown. Then press the softkey under the pump you would like to select, and this will take you to the run screen of the appropriate pump.

CONSTANT FLOW RATE, refer to 3.5.1

This mode is used when the flow rate must remain constant during the pumping operation.

CONSTANT PRESSURE, refer to 3.5.2

The constant pressure mode is used when the application of fixed pressure throughout the pumping operation is required. The pump will maintain the desired pressure by positive or negative displacement of the piston.

3.5.1 Constant Flow

To set constant flow operation, use the following procedure:

1. Press the CONST FLOW key on the keypad. “CFa” will be displayed in the upper left corner of the screen. This denotes that you will be defining constant flow parameters for pump A. If you wish to define parameters for pump B or C, press softkey D, select pump, and then press softkey A, B, or C to select pump A, B, or C, respectively.

☑ Note

If the main menu is displayed, you must press softkey D under CONST FLOW key.

2. Press the A softkey to change the flow rate. The words “ENTER FLOW RATE” will flash on the screen.
3. Use the number keys to enter the desired flow rate.

☑ Note

If you make an error, press the CLEAR ENTRY key to delete your last keystroke. Each time you depress the CLEAR ENTRY key, you will delete one character.

4. Press the ENTER key once the desired flow rate is displayed.
5. Press the RUN key to begin pump operation.

3.5.2 Constant Pressure

Programming a constant pressure operation only requires a few keystrokes. Use the following procedure:

1. Press the CONST PRESS key on the keyboard, CPa will be displayed in the upper left corner of the screen. This denotes that you will be defining constant pressure parameters for pump A. If you wish to define parameters for pump B or C, press softkey D, select pump, and then press softkey A, B, or C to select pump A, B, or C, respectively.

☑ Note

If the main menu is displayed, you must press softkey D under RETURN before pressing the CONST PRESS key.

2. Press the A softkey to indicate to the program that you wish to enter the pressure. The words “ENTER PRESSURE” will flash on the screen.
3. Use the number keys to enter the desired pressure.

☑ Note

If you make an error, press the CLEAR ENTRY key to delete your last keystroke. Each time you depress the CLEAR ENTRY key, you will delete back a character.

4. Press the ENTER key once the desired pressure is displayed.
5. Press the RUN key to initiate pump operation.

3.6 External Control

The pump can be externally controlled for pressure or flow rate operation with an analog voltage or through the serial interface. Controlling the pump with an analog voltage is discussed in section 3.3.9.

The serial interface allows you to control the pump operation from an IBM-PC or compatible computer which has an RS-232-C serial output. The serial interface accepts English command words from the computer, like constant pressure, refill, etc. For more information see Section 4, Serial Interface.

3.7 Remote RUN/STOP

The HL series syringe pump RUN/STOP function can be externally controlled by a switch contact closure or TTL input. The input voltage is 5 volts and is internally pulled high (RUN). The input is level sensitive (must remain high for RUN or low for STOP) and must be high for normal operation of serial (RS-232) control.

To use the remote RUN/STOP feature, first press RUN or force the RUN/STOP pin low to enable the pump. Thereafter the RUN/STOP pin will control operation. Pressing STOP on the front panel will override the RUN/STOP pin.

3.7.1 Wire Connections

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

Two wires are required for external RUN/STOP control. The digital common or ground wire should be connected to one of the four DIGITAL GROUND terminals of the ACCESSORY connector on the controller rear panel. The control wire should be connected to terminal 1, under DIGITAL INPUT. If an electrically isolated relay is used, one relay terminal should be connected to digital ground and the other to terminal 1, under DIGITAL INPUT.

If two pumps are used with the controller, the second control wire should be connected to terminal 2, under DIGITAL INPUT.

If three pumps are used with the controller, the third control wire should be connected to terminal 3, under DIGITAL INPUT or to auxiliary (P11) pin 17.

HL Series Syringe Pumps

Section 4 Serial Interface

4.1 Introduction

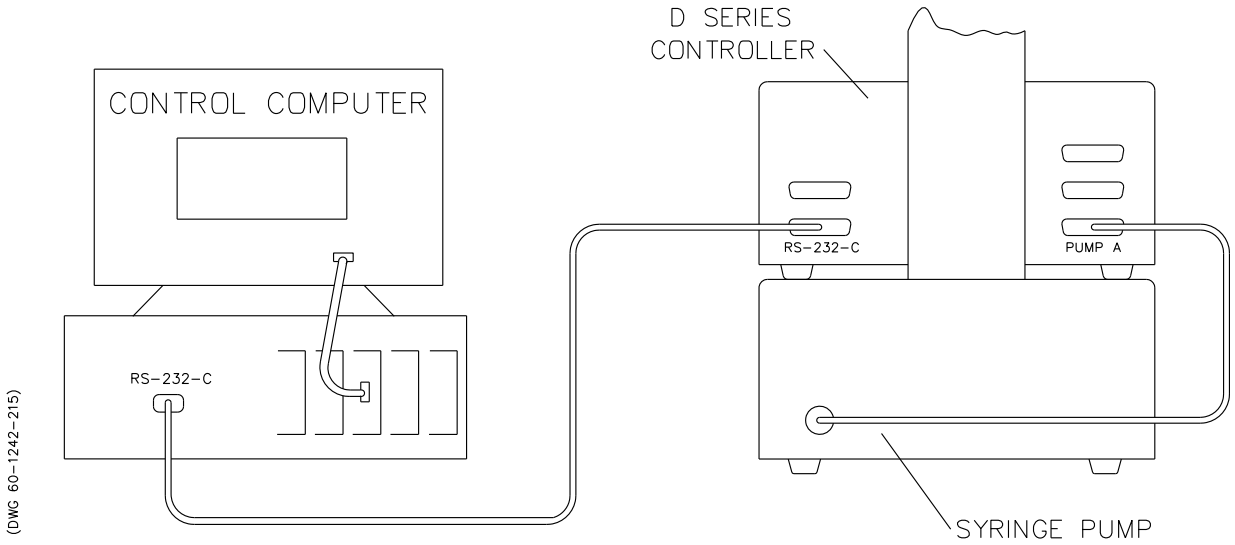
The Isco HL Series pump can be remotely controlled by a computer through a built-in RS-232-C serial interface. Up to three HL Series pump modules can be serially controlled from each HL Series controller. This function is supported in two ways: Isco LabView™ software or by user written software. To write software for the HL Series pumps, you must be familiar with the Isco DASNET communications protocol and the serial commands recognized by the pumps.

- Section 4.2 describes the DASNET protocol
- Section 4.3 describes the proper cabling connections for serial control
- Section 4.4 details the serial commands
- Section 4.5 details the procedure for placing your controller(s) in serial control mode.

4.2 User-written Software

When designing software to control the HL Series pumps, you must follow the DASNET communications protocol. This protocol allows a number of instruments to be controlled from a single RS-232-C serial port. Up to seven HL Series controllers may share a single serial data channel, with each controller only accepting commands that are meant for it. Each pump controller can then control up to three pumps each. Figure 4-1 shows a simple system where the PC is connected to the serial port on the rear panel of the pump controller (shown sitting on top of the pump module). The pump control cable is attached to the pump A connector on the rear panel of the controller.

Figure 4-1 Single serial network connection example (rear view)



4.2.1 DASNET

DASNET converts your direct serial commands into a form recognizable to our instruments. Using a computer language such as C or BASIC, serial commands can be entered, converted, and then sent to your instrument.

Table 4-1 is an example BASIC language program which performs the required portion of the DASNET serial protocol. Table 4-2 is an example of a C language program which does the same. Both of these programs are available on CD-ROM (P/N 60-1245-096) in the sleeve at the back of the printed manual.

Network communications are always initiated by the network controller, which is typically a computer. Messages from the instruments are in response to messages from the network controller. All information on the network is transmitted as groups of ASCII characters called frames. The message frames contain the origin of the message, the destination of the message, and a checksum to verify the validity of the message.

Each instrument is provided with a method of selecting unit identification numbers and a baud rate. For proper operation, each instrument must be set to a unique unit identification number (see section 4.5). It is also important that each unit's baud rate is set to the same speed. Possible baud rates are 1200 and 57600.

Table 4-1 Example of BASIC program to demonstrate conversion of pump commands to DASNET frames

```
1 CLS : Z$ = "": PRINT "INPUT ALL ENTRIES IN CAPITAL LETTERS"
5 INPUT "INPUT UNIT ID >> ", UNITNUM'GET UNIT NUMBER
30 REM OPEN COM PORT SET FOR COM2 EDIT TO COM1 IF NEED
40 OPEN "COM2:1200,N,8,1,ASC" FOR RANDOM AS #2
50 PRINT : INPUT "ENTER STRING (HIT Q TO EXIT) >> ", I$'GET OUTPUT STRING FROM USER
65 IF I$ = "" THEN GOTO 50                'IF BLANK INPUT THEN GO BACK
70 IF I$ = "Q" THEN GOTO 200              'IF "Q" INPUT THEN QUIT
80 GOSUB 10000                            'CONVERT STRING TO DASNET FORMAT
90 GOSUB 20000                            'OUT DASNET STRING TO COM 2
120 PRINT "DASNET FORMATTED CMD >> "; O$  'OUTPUT FORMATTED CMD TO USER
124 PRINT : PRINT ">>>> PRESS CTRL-C IF NO RESPONSE FROM PUMP <<<<"
125 LINE INPUT #2, Z$                     'GET RESPONSE FROM PUMP 'CR' ENDS STRING
127 PRINT "DASNET RESPONSE >> "; Z$       'PRINT RESPONSE
128 Z$ = ""                               'CLEAR BUFFER
130 GOTO 50                               'GO BACK
200 CLOSE #2                              'CLOSE COM2
210 SYSTEM                                'END PROGRAM AND EXIT TO DOS

10000 REM this SUBROUTINE will convert a string (I$) into a string (O$)
10005 REM in DASNET protocol
10015 REM UNITNUM=UNIT NUMBER OF PUMP
10020 REM AFTER THE STRING IS SENT TO PUMP A CR IS REQUIRED TO TERMINATE MESSAGE
10030 REM VAR USED O$,I$,IL,Y$,LI,SUM,CSUM,UNITNUM
10100 O$ = CHR$(ASC("0") + UNITNUM)       'PUT UNIT ID FIRST IN OUTPUT STRING
10110 IL = LEN(I$)                        'GET LENGTH OF INPUT STRING
10115 REM IF INPUT IS JUST "R" ADD SPACE AND JMP BY # CHAR
10120 IF I$ = "R" THEN I$ = I$ + " ": GOTO 10180
10130 O$ = O$ + "R"                       'ADD "R" TO OUTPUT STRING
10140 Y$ = HEX$(IL)                       'GET # OF CHAR IN INPUT STRING IN HEX
10150 IF IL < 16 THEN Y$ = "00" + Y$      'PAD OUT # CHAR IN STRING IF NEED
10160 IF IL >= 16 THEN Y$ = "0" + Y$      'IF MORE THAN 16 THEN ONLY ONE PAD
10170 O$ = O$ + Y$                        'ADD # CHAR TO OUTPUT STRING
10180 O$ = O$ + I$                        'ADD INPUT STRING TO OUTPUT STRING
10190 IL = LEN(O$): SUM =                 'GET NEW LENGTH AND CLEAR SUM OUT
10200 FOR LI = 1 TO IL                    'TO ADD ALL ASCII FOR SUM
10210 SUM = SUM + ASC(MID$(O$, LI, 1))    'GET THE ASCII # OF (LI) ASCII CHAR
10220 NEXT LI
10230 REM THIS FINDS THE CHECKSUM
10235 REM THE # IS FIRST SUBTRACTED FROM 256
10236 REM THEN ANDED WITH 255 TO AND OFF EXTRA BITS
10240 CSUM = (256 - SUM) AND 255          'GET CHECK SUM
10245 IF CSUM < 16 THEN O$ = O$ + "0"     'PAD OUT CSUM IF NEED
10250 O$ = O$ + HEX$(CSUM)                'PUT AT END OF OUTPUT STRING
10270 RETURN                              'DONE RETURN

20000 REM THIS SUBROUTINE SENDS O$ TO THE COM PORT
20010 PRINT #2,                           'CR';      'SEND CR TO COM PORT
20020 PRINT #2, O$;                       'SEND O$ TO COM PORT
20030 PRINT #2, 'CR';                     'SEND CR TO COM PORT
20040 RETURN                              'DONE
```

Note: Polling is part of the DASNET definition but is not required and is not shown in this example. If this program is run on a PC as is, the commands entered at the keypad will be output on serial port 2. This code was written in QBasic, version 4.5.

Table 4-2 Example of C program to demonstrate conversion of pump commands to DASNET frames

```
#include<stdio.h>
#include<conio.h>
#include "b:comm.c"                          /* edit to path needed */
                                             /* a 'C' example of DASNET serial control */
int conv_das();
unsigned char in[256],out[256],buf[256];
char unitnum;
main()
{
unsigned port;
int speed;
   cputs("ENTER UNIT ID=");                  /* get parms */
   scanf("%d",&unitnum);
   cputs("ENTER COM PORT=");
   scanf("%d",&port);
   cputs("ENTER BAUD RATE=");
   scanf("%d",&speed);
   comm_open(port,speed);                    /* open comm port */
   in[0]=50;
   cputs("ALL ENTRIES IN CAPS\n\r");
while(1)
   cputs("\n\rENTER STRING(Q TO QUIT) >>>");
   cgets(in);
   if(in[2]=='Q') break;
   conv_das(&in[2],out);                     /* convert string */
   cputs("\nDASNET FORMATTED OUTPUT >>>");
   puts(out);                                /* output converted string */
   comm_putc(0x0d);                          /* send "CR" to serial port */
   dput(out);                                /* output converted string to serial port */
   comm_putc(0x0d);                          /* end with a "CR" */
   dgets(buf);                               /* get response */
   cputs("\nDASNET RESPONSE >>>");
   puts(buf);                                /* output response */
   comm_flush();                             /* flush serial buffer to start again */
   }
comm_close();
}
                                             /* dasnet conversion utility */
conv_das(char *in, char *out)
{
unsigned sum;
char *c_ptr;
c_ptr=out;                                   /* point to output */
*out++=unitnum+0x30;                         /* put id first */
*out++='R';                                  /* add "R" to output */
if (!strcmp(in,"R"))                         /* if just "R" add space to string */
  {
  *out++=' ';
  *out++=0x00;
  }
else                                          /* add # char to string */
  sprintf(out,"%3.3X%s",strlen(in),in);
for (sum=0 ; *c_ptr; c_ptr++)                 /* add all chars together */
   sum+=*c_ptr;
sum=(0x100 - sum) & 0x0FF;                   /* get check sum */
sprintf(c_ptr,"%2.2X",sum);                  /* insert into string */
}
```

Note: Polling is part of the DASNET definition but is not required and is not shown in this example. This code was written in TC, version 4.5.

Other baud rates of 300, 1200, 2400, 4800, 9600, 19200, 38400, and 57600 are supported by the HL Series pumps but are not part of the Isco defined communications standard. Electrical standards are RS-232-C; connector pin usage is outlined in Table 4-3. Characters consist of 1 start bit, 8 data bits (low order first with 8th bit always set to zero), and 1 stop bit. There is no parity bit used. All characters will be printable ASCII characters. Control characters (0-1FH) are ignored except for carriage return (0DH).

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

Table 4-3 External control connector serial pin connections

Pin No.	Name	Use
1	CHASSIS GROUND	Used to connect to the shield of the interconnect cable.
2	RECEIVE	Serial interface data input. Standard RS-232-C signal levels.
3	TRANSMIT	Serial interface data output. Standard RS-232-C signal levels.
4	REQUEST TO SEND	RTS chain - RS-232-C input is buffered and connected to pin 21.
5	CLEAR TO SEND	CTS buffered RS-232-C output of pine 25 input.
6	+11 VDC	DATA SET READY is held on.
7	COMMON	Signal common for all signals.
8	+11 VDC	DATA CARRIER DETECT is held on.
9	+5 VDC	Test Voltage.
10	-11 VDC	Negative test voltage.
14	TRANSMIT CHAIN	Serial data from next unit.
16	RECEIVE CHAIN	Serial data to next unit.
21	RTS CHAIN	RTS buffered RS-232-C output of pin 4 input.
25	CTS CHAIN	CTS chain -RS-232-C input is buffered and connected to pin 5.
NOTE: Only pins 2, 3, and 7 are required for serial interface to one controller.		

The serial unit number and baud rate can be changed from the default values through the MENU key. Select SERIAL under the menu; and adjust the values using the softkeys (see section 4.5).

There are three types of operation within the network: network controller, master, and slave. A computer typically serves as the network controller. It supervises all data flow on the network. It also polls each unit which initiates data transfer and commands.

> ☑ ***Note***
>
> The network controller (typically a PC) should not be confused with the pump controller. The network controller is used in addition to the pump controller.

The slave unit simply responds to commands accordingly. The HL Series pump functions as a slave unit. These functions may be combined in one unit; *i.e.*, a computer can function as both a network controller and a master.

All data transfers are in a frame format. When the network controller polls an instrument, it will start to respond within 200 ms. If it does not reply, it will be polled again. If after three attempts at polling it does not reply, it will be dropped from the polling rotation. When the instrument does respond, the polling rotation does not advance until an error-free transfer has occurred.

The frame format for data transfers from the network controller is as follows:

destination\acknowledgement\message source \length\message\checksum\[CR]

- The **destination** is the 1-digit unit identification number of the instrument to receive the message.
- **Acknowledgment** is one character to indicate the success of the previous transmission. There are three possibilities: (1) E means error, resend the message immediately (E is sent by the network controller only. Other units signify errors by not replying; causing the controller to resend the message). (2) B means busy, resend message at next poll. (3) R signifies previous message was received.
- **Message source** is the unit ID of the unit that originated the message. If there is no message, this location is a space (20H).
- **Length** is the length of the message in 2 digit, hexadecimal format. Maximum length is 256, with 256 being represented by a 00. This field is eliminated if there are no messages.
- **Message field** is the area where the actual information is located. The maximum length is 256 characters long.

- **Checksum** is also a 2 digit hexadecimal number. This number, when added to all the previous characters in the message (excluding control characters), will result in a sum. If there are no errors, the result of modulo 256 division of this sum should be 0.

Examples

Frame is R304STOPD1[CR] =

(R) (3) (0) (4) (S) (T) (O) (P)
52H + 33H + 30H + 34H + 53H + 54H + 4FH + 50H + D1H = 300H

300H MODULO 256 = 00

It is important to note that all characters are converted to the ASCII equivalent and added, except for the checksum. The two characters of the checksum are converted to hexadecimal numbers and concatenated to form a single two-digit number. This number is then converted to its ASCII equivalent and added to the end of the message.

Hexadecimal Format Using MODULO

Step 1: 22FH = 52H + 33H + 30H + 34H + 53H + 54H +4FH + 50H

Step 2: 2FH = 22FH ⁄ 100H (Modulo)

```
        2R2FH
100H ) 22FH
      −200H
       2FH
```

Step 3: D1H = 100H − 2FH

Step 4: Convert D1H to ASCII (Hex) and put at end of message.

Step 5: Put a “CR” (0DH) at the end of message for end of frame.

Decimal Format Using MODULO

Step 1: 559 = 82 + 51 + 48 + 52 + 83 + 84 + 79 + 80

Step 2: 47 = 559 ⁄ 256 (Modulo)

```
        2R47
256 ) 559
      −512
       47
```

Step 3: 209 = 256 − 47

Step 4: Convert 209 to ASCII (Hex) and put at end of message.

Step 5: Put a “CR” (13) at the end of message for end of frame.

Hexadecimal Format Using NO MODULO

Step 1: 22FH = 52H + 33H + 30H + 34H + 53H + 54H + 4FH + 50H

Step 2: FED1H = 100H − 22FH

Step 3: D1H = FED1H & offH

Step 4: Convert D1H = to ASCII (Hex) and put at end of message.

Step 5: Put a "CR" (0DH) at the end of message for end of frame.

Decimal Format Using NO MODULO

Step 1: 559 = 82 + 51 + 48 + 52 + 83 + 84 + 79 + 80

Step 2: −303 = 256 − 559

Step 3: 209 = 303 & 255

Step 4: Convert 209 into ASCII (Hex) and put at end of message.

Step 5: Put a "CR" (13) at the end of message for end of frame.

The carriage return "CR" signifies end of frame.

The format for frames sent from the unit to the network controller is as follows:

acknowledgement\message destination
\length\message\checksum\[CR]

All the parameters are as previously described except message destination. Message destination is the 1-digit identification number of the unit that the message is sent to.

An example of a typical data exchange is summarized below. For illustration, we will assume the network consists of a computer serving as a combination network controller and master. There will be one slave unit; a Model 260HL pump. Details on the pump message format are in section 4.4. The computer will be unit #0, and the pump will be unit #6.

Network Controller and Master Unit #0

```
[CR]1R 5D[CR]
```

☑ *Note*

A [CR] must start the network. The controller is checking for the presence of unit #1 but will get no response in 200 ms because there is no unit 1.

Network Controller and Master Unit #0

1R 5D[CR]
Still no response.

Network Controller and Master Unit #0

1R 5D[CR]
Still no response, so unit 1 will be dropped from the poll.

Network Controller and Master Unit #0

2R 5C[CR]
Checks for unit 2 but will get no response in 200 ms because there is no unit 2.

Network Controller and Master Unit #0

2R 5C[CR]
Still no response.

Network Controller and Master Unit #0

2R 5C[CR]
Still no response, so unit 2 will be dropped from the poll.

In this way units 3-5 will be checked and dropped from the poll.

Network Controller and Master Unit #0

6R 58[CR]
Check for presence of unit 6.

Unit 6

R 8E[CR]
Unit 6 responds.

Network Controller and Master Unit #0

7R 57[CR]
Since unit 7 does not exist, it will be dropped from the polling scheme.

Network Controller and Master Unit #0

6R008IDENTIFY84[CR]
The master verifies the fact that unit 6 is a Model ___HL. In this example, the master and the network controller are a single unit. If they were separate units, the master would send the inquiry to the network controller; then the network controller would send the message to the slave unit the next time it is polled. The slave would respond with the message to the network controller. The next time the master is polled, the message would be relayed. The same sequence would occur with all messages. Since the master and the network controller are combined in this example, the relaying of messages is not necessary.

Unit 6

R027SERIES=1240-02__, Model ___HL PUMP, REV __XX[CR]
The pump responds with identity and software revision letter. (In this example 02__ would be 021; Model ___HL would be 260HL; REV __ signifies the software revision, XX would be replaced by the correct checksum, which is B4.)

Network Controller and Master Unit #1

6R006REMOTE16[CR]
This places the pump in the remote mode.

Unit 6

R 8E[CR]
The pump acknowledges that it accepted the command.

Network Controller and Master Unit #1

6R00ACONST FLOWF8[CR]
This puts the pump into constant flow rate mode.

Unit 6

R 8E[CR]
The pump verifies that it received the message.

Network Controller and Master Unit #1

6R009FLOW=1.00AB[CR]
This sets the pump's flow rate to 1.00 ml per minute.

Unit 6

R 8E[CR]
The pump verifies that it received the message.

Network Controller and Master Unit #1

6R 58[CR]
Polls the pump.

Unit 1

R 8E[CR]
Pump responds.

Network Controller and Master Unit #1

6R003RUNF0[CR]
The pump is started.

Unit 1

R 8E[CR]
The pump responds.

The system is now running and the network controller continues the polling scheme. If the controller gives an improper command, the units will respond with a problem message indicating the type of error.

The format of the message is given in section 4.4 of this manual and specifies the commands used for this instrument. It is important to follow this format. Spaces are ignored anywhere within the message field. Commands must be in uppercase letters. The network definition allows multiple commands in a message field when delimited by semicolons, but the HL Series controller is limited to single commands. It will respond with a PROBLEM=INVALID COMMAND message.

4.3 Cabling for Serial Control

The cabling scheme for your system will depend on the number of instruments you need to control. The computer is always connected from the serial port to the serial port(s) of the HL Series controller(s) it is controlling. Each controller is connected to its pumps in the normal fashion, *i.e.* the pump control cables are attached to the pump A, B, and C connectors on the rear panel of the pump controller. The cable you select to connect your network will depend on the type of serial port your computer has and the number of controllers you wish to connect.

Cable Connections

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

One or two controllers:

If only two units are being connected in the network, then a single cable, P/N 68-1020-198, is all that is required. It is connected between the 9-pin serial output connector of the computer and the RS-232-C connector on the rear of up to two controllers, as shown in Figure 4-2.

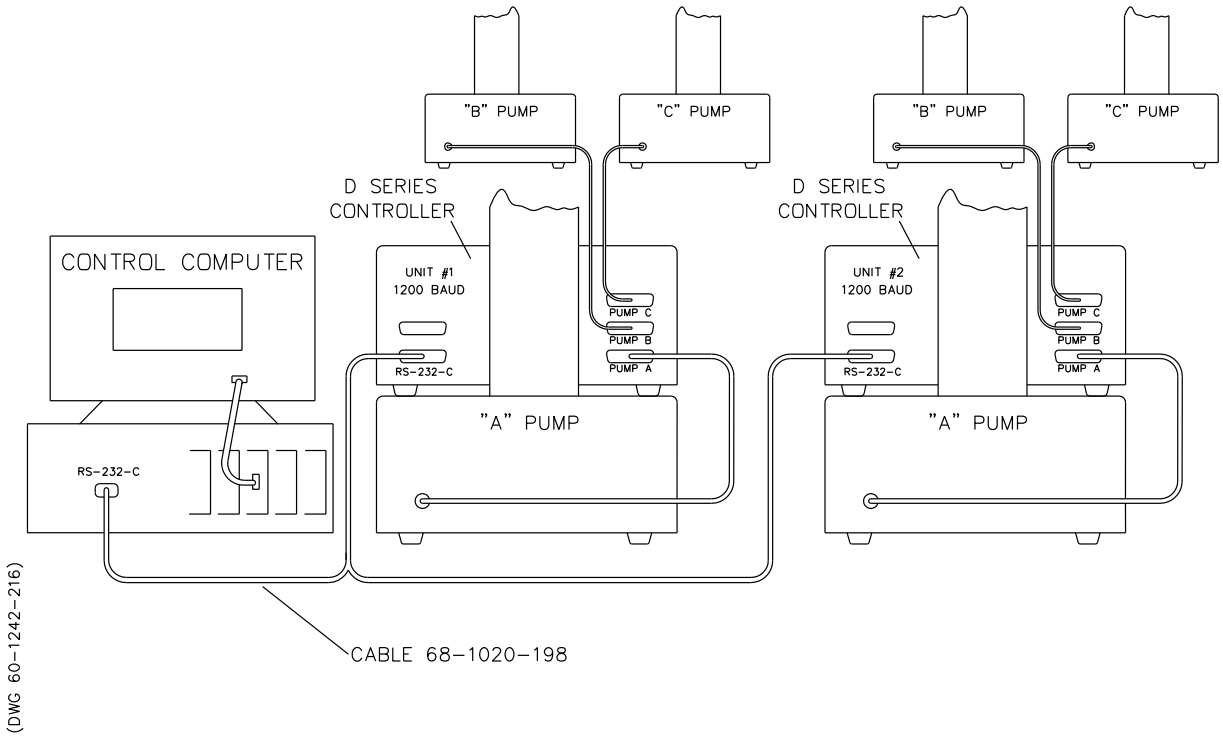
☑ *Note*

In order for the network to operate properly, all instruments connected to the network must be turned on even if they are not being used.

Three or more controllers:

If additional instruments are to be connected in series, a special daisy chain cable, P/N 68-1020-180, will be required. The 1020-180 cable is attached to the last connector on the 1020-198 cable shown, in Figure 4-2, and then plugged into the RS-232-C connectors on the back of the additional controllers.

Figure 4-2 Serial network connection example



4.4 Serial Commands for the HL Series Pump

Table 4-4 is a list of the serial commands recognized by the pump. These commands are the message part of the DASNET protocol. The operand always follows the equals sign. The REMOTE command must be sent once, before any command that changes the operation of the pump will be accepted.

> ☑ ***Note***
>
> When setting a value, the serial command will always be followed by an equal sign.

Table 4-4 Serial Commands

NOTE: The letter after the commands signify which pump is being addressed. If no letter is shown, pump A is the pump being addressed.

Command	Description
%B=#	Enter # for percentage.
ANLG1	Status of the analog voltage input on pin 21, P114. See NOTE 1.
ANLG2	Status of the analog voltage input on pin 15, P107 auxiliary DB25 connector and on analog input 3 of the accessory connector. See NOTE 1.
ANLG3	Status of the analog voltage input on analog input 2 of the accessory connector. See NOTE 1.
ANLG4	Status of the analog voltage on analog input 1 of the accessory connector. See NOTE 1.
ANLG5	Status of the analog voltage input on pin 2, P107 auxiliary DB25 connector. See NOTE 1.
CLEAR	Stops all motors, sets flow rate and pressure setpoints to zero.
CONTIN CONST FLOW	Puts pump in continuous flow under constant flow mode.
CONTIN CONST PRESS	Puts pump in continuous flow under constant pressure mode.
CONST FLOW CONST FLOWB CONST FLOWC	Put pump in constant flow mode.
CONST PRESS CONST PRESSB CONST PRESSC	Put pump in constant pressure mode.
DIGITAL	Returns the status (High or Low) of the digital outputs. Format is digital = xxxxxxxx, where “x” is either “H” or “L”. The status order returned corresponds with the outputs 1—8.
DIGITAL = xxxxxxxx 1——— 8	Sets the digital output either High or Low, where “x” is either “H” or “L”. The order corresponds with the outputs 1—8.
DIG CONTROL	Returns the status of the digital output control bits as either REMOTE (R) or INTERNAL (I). The return message format is DIG CONTROL=xxxxxx, where “x” is either “R” or “I”. “R” indicates the corresponding bit is controlled remotely; and “I” indicates the corresponding bit is controlled internally by pump software. The status order returned corresponds with the outputs 1—8.
DIG CONTROL = xxxxxxxx 1——— 8	Sets the digital output control bits to either internal or remote, where “x” is either “R” for REMOTE or “I” for INTERNAL CONTROL. “R” indicates the corresponding bit will be controlled remotely (through the serial port). “I” indicates the corresponding bit will be controlled internally by pump software. The order corresponds with the outputs 1—8.
FLOW	Returns the delivering pump’s flow rate in continuous pumping mode. In INDEPENDENT mode it returns the pump A flow rate.
FLOWA FLOWB FLOWC	Returns the actual flow rate of the pump.
FLOW=# FLOWB=# FLOWC=#	Returns the actual flow rate of the pump Enter # for a flow rate setpoint (constant flow mode). Format is XXX.XXXXXXX ml/min. Only 5 figures are significant. Leading and trailing zeros are not required.

Table 4-4 Serial Commands (Continued)

NOTE: The letter after the commands signify which pump is being addressed. If no letter is shown, pump A is the pump being addressed.

Command	Description
G G&	Gets pump information. "G" returns a text string that contains current pressure, analog input, and digital input information. "G&" is the Get All command. This returns the same information as "G," plus flow rates, units, operation status, and more. Refer to 4.4.1 for a complete description of this serial command.
IDENTIFY	Pump responds "SERIES=1240-0___, MODEL ____HL PUMP; REV__." For each pump, REV__ is the internal pump program software revision. (For example, if the controller was attached to two 100HLs, the message would read "SERIES=1240-024, MODEL 100HL PUMP; SERIES=1240-024, MODEL 100HL; REV__.") The series number is the original catalog number for the pump type. It may not match the production series number on the pump serial label. SERIES=1240-024, MODEL 100HL PUMP SERIES=1240-021, MODEL 260HL PUMP SERIES=1240-025, MODEL 500HL PUMP SERIES=1240-052, MODEL 1000HL PUMP
INDEPENDENT	Put pumps in Independent mode.
IPUMPA=1, IPUMPA=0 IPUMPB=1, IPUMPB=0 IPUMPC=1, IPUMPC=0	Turns the pressure integral control On and Off for the pump indicated. 1 = ON 0 = OFF
LIMITS LIMITSB LIMITSC	Returns the pressure and flow rate limits.
LOCAL	Returns the instrument to local control. Front panel control is enabled and all motors are stopped (if control was previously remote).
MAXFLOWA=# MAXFLOWB=# MAXFLOWC=#	Enter # to designate the maximum flow rate setpoint.
MAXFLOWA MAXFLOWB MAXFLOWC	Returns the maximum flow rate setpoint.
MAXPRESSA=# MAXPRESSB=# MAXPRESSC=#	Enter # to designate the maximum pressure setpoint.
MAXPRESSA MAXPRESSB MAXPRESSC	Returns the maximum pressure setpoint.
MFLOWA=# MFLOWB=# MFLOWC=#	Enter # to designate the maximum flow limit in constant pressure mode.
MFLOWA MFLOWB MFLOWC	Returns the maximum flow limit setpoint.
MINFLOWA=# MINFLOWB=# MINFLOWC=#	Enter # to designate the minimum flow rate setpoint.
MINFLOWA MINFLOWB MINFLOWC	Returns the minimum flow rate setpoint.

Table 4-4 Serial Commands (Continued)

NOTE: The letter after the commands signify which pump is being addressed. If no letter is shown, pump A is the pump being addressed.

Command	Description
MINPRESSA=# MINPRESSB=# MINPRESSC=#	Returns the minimum flow rate setpoint.
MINPRESSA MINPRESSB MINPRESSC	Returns the minimum pressure setpoint.
PRESS=# PRESSB=# PRESSC=#	Enter # to designate pressure setpoint (constant pressure mode).
PRESS	Returns the delivering pump pressure in continuous pumping mode. In INDEPENDENT mode it returns the pump A pressure.
PRESSA PRESSB PRESSC	Returns the actual pressure of the pump.
PRESSCNTRLDIFF1	Sets the pressure control input to Analog input 1, with a pressure range of 50 psi.
PRESSCNTRLDIFF1=XXXXX	Sets the pressure control input to Analog input 1 and sets the pressure range. The range is 1 to 5000. the units are psi, with a value of 5000 representing 5000 psi at 5 volts.
PRESSCNTRLDIFF2	Sets the pressure control input to Analog input 2, with a pressure range of 500 psi at 5 volts.
PRESSCNTRLDIFF3	Sets the pressure control input to Analog input 2, with a pressure range of 5000 psi at 5 volts.
PRESSCNTRLNORM	Sets the pressure control input to the standard input.
PRESSDIFF=XXXXX	Differential pressure setpoint. (PSI*10) 0 to 50,000 maximum (0 to 5000 psi)
PRESSDIFF	Reads the differential pressure value. (PSI*10) The transducer can also be read via the “ANGLx” serial commands.
RANGEA RANGEB RANGEC	Provides scaling information for the system parameters. See 4.4.2 for more information about this serial command.
RAPIDA RAPIDB RAPIDC	Activates the automatic rapid pressurization cycle (constant flow mode only).
REFILL REFILLB REFILLC	Move cylinder to bottom at preset refill rate.
REFILL=# REFILLB=# REFILLC=#	Enter # to designate refill rate.
REMOTE	Disables controller front panel control and enables all serial commands. Stops all motors (if control was previously local).
RLIMITA RLIMITB RLIMITC	Returns the refill flow rate limit.

Table 4-4 Serial Commands (Continued)

NOTE: The letter after the commands signify which pump is being addressed. If no letter is shown, pump A is the pump being addressed.

Command	Description
RSVP RSVPB RSVPC	Pump responds with “READY” message.
RUN RUNB RUNC	Same as front panel. Initiates pumping.
SETFLOWA SETFLOWB SETFLOWC	Returns the flow rate setpoint.
SETPRESSA SETPRESSB SETPRESSC	Returns the pressure setpoint.
STATUSA STATUSB STATUSC	Returns with status of pump. May be any combination of responses listed below. **STATUS=** STOP, RUN, REFILL, HOLD, EQUIL., LOCAL, REMOTE, EXTERNAL **PROBLEM=** OVER PRESSURE, UNDER PRESSURE, CYLINDER FULL, CYLINDER EMPTY, MOTOR FAILURE
STOP STOPB STOPC	Same as front panel, except that pump remains under remote serial control.
UNITSA=	Enter the desired flow or pressure units after the equal sign. Acceptable values are: ATM, BAR, KPA, PSI, ML/MIN, ML/HR, UL/MIN, UL/HR. (Sets all pumps.)
VOLA VOLB VOLC	Return the volume remaining in cylinder in ml. Format is “XXX.XXXX” ml.
VOLTOT	Returns the total volume delivered when using continuous flow.
VOL RESET	Will reset the volume total to zero.
ZEROA ZEROB ZEROC	“Zeros” the pressure sensor offset for analog input 1.
ZERODIFF1 ZERODIFF2 ZERODIFF3	“Zeros” the pressure sensor offset for the respective analog input.

Table 4-4 Serial Commands (Continued)

NOTE: The letter after the commands signify which pump is being addressed. If no letter is shown, pump A is the pump being addressed.

Command	Description
NOTE 1: The analog input range is -1.5 to 11.6 volts. There is NO conversion of the returned number. The number returned (0 to 65535 decimal) will have an offset of 7500 added to the number (7500 = 0 volts) and a scale of 5000 for every 1 volt, for example: $\frac{\text{number} - 7500}{5000} = \text{volts}$ $\frac{(32500 - 7500)}{5000} = 5 \text{ volts}$	
NOTE 2: The only pump B commands accepted in continuous pumping mode are: %B, FLOWB, LIMITSB, PRESSB, REFILLB, REFILLB=, STATUSB, VOLB.	

4.4.1 Get Status Command

The "G" and "G&" serial commands retrieve information from the pump controller. Each command returns a text string which can be read as shown in Figures 4-3 and 4-4.

Figure 4-3 Get Status String

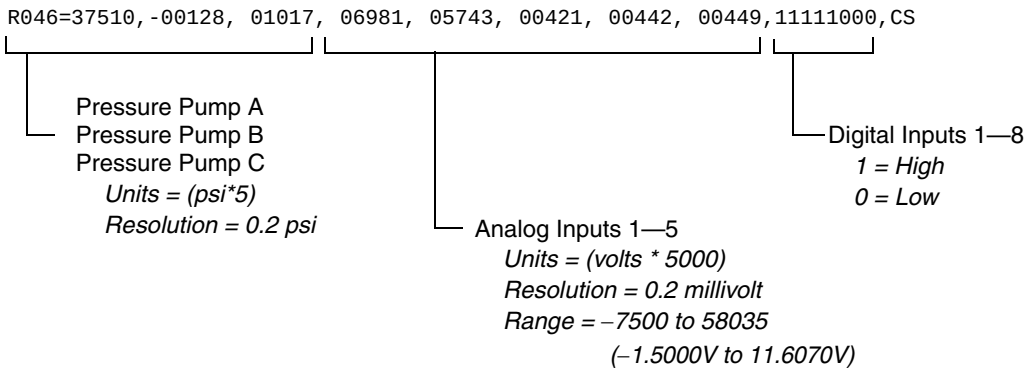


Figure 4-4 Get All Status String

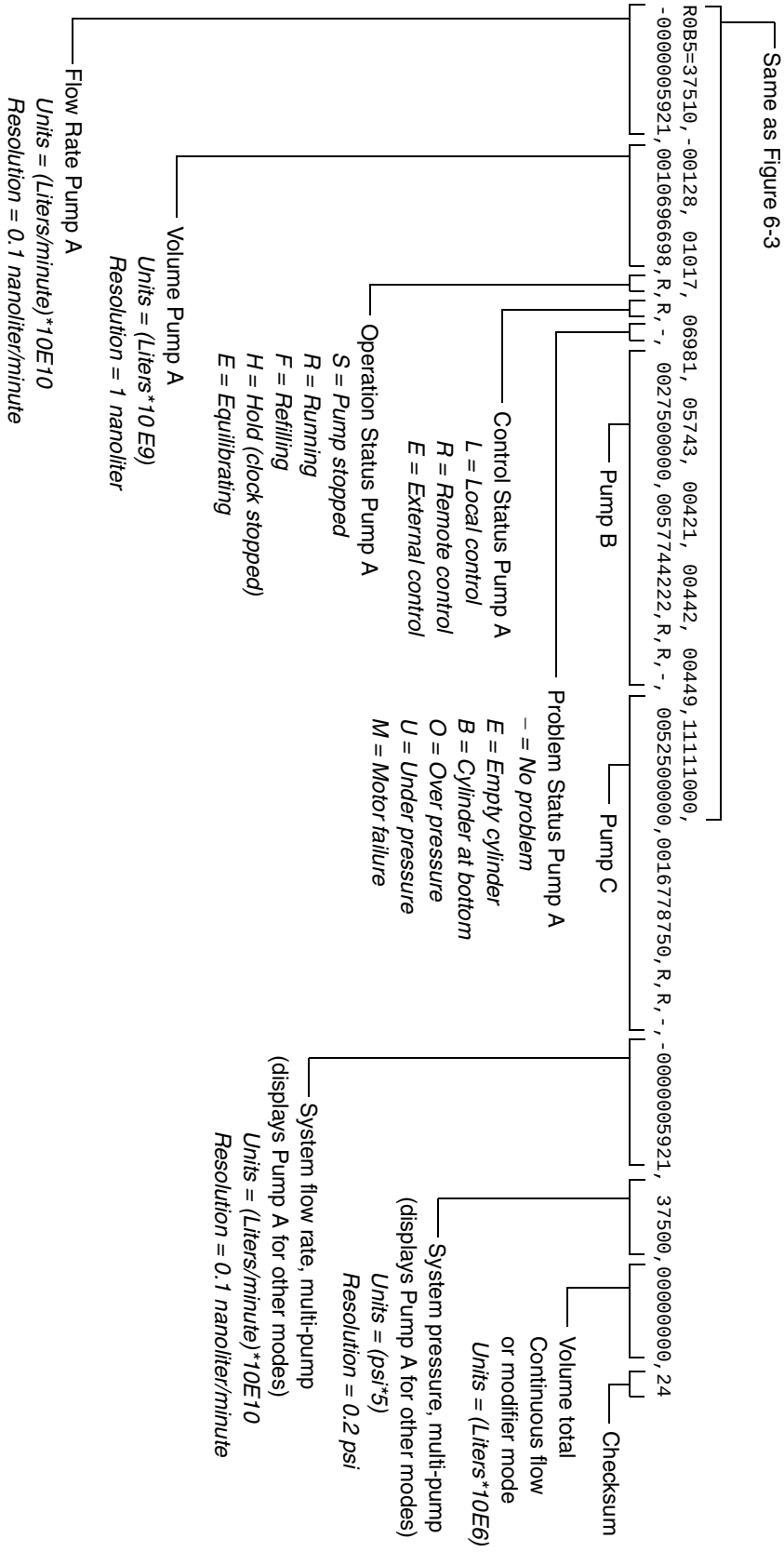
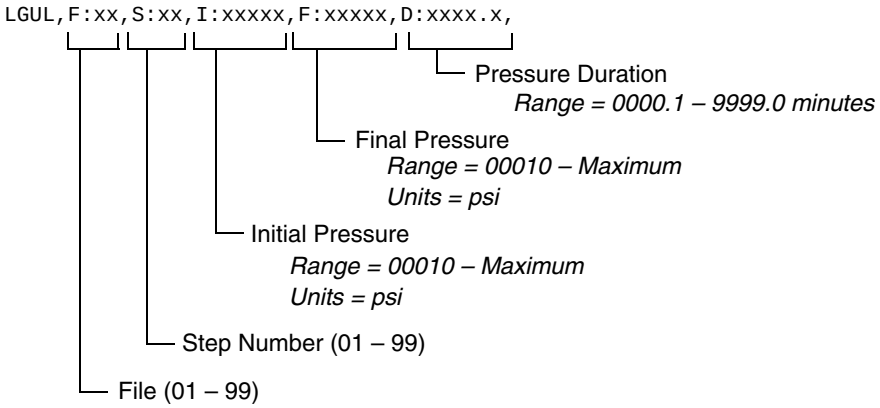


Figure 4-5 Upload Commands - Single pump pressure programming



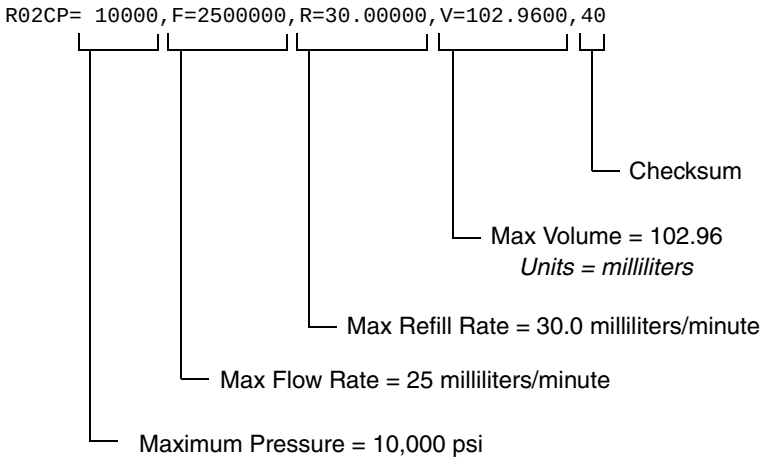
4.4.2 Range Command

The RANGE command provides scaling information for the system parameters. For example,

6R006RANGEA34

may return a string similar to the one shown in Figure 4-6.

Figure 4-6 Range Serial Commands



4.4.3 Error Messages

If an error occurs in a message, one of the following responses will be sent. The format of an error message is "PROBLEM=_____." Refer to Table 4-5.

Table 4-5 Error Messages

Error	Description
PROBLEM=LOCAL MODE	The pump was sent a command before being placed in remote mode. See Section 4.4.
PROBLEM=INVALID COMMAND	The command sent was not recognized by the pump.
PROBLEM=INVALID OPERAND	The operand (character(s) following the = sign) is missing or is incorrect; *e.g.*, the number was too large.
PROBLEM=PUMP RUNNING	The command sent is only valid when the pump is stopped.
PROBLEM=OVERPRESSURE PROBLEM=UNDERPRESSURE	Sent in response to a high or low pressure limit condition.
PROBLEM=CYLINDER EMPTY	Sent when the pump cylinder is empty.
PROBLEM=CYLINDER FULL	Sent when the pump cylinder is full.
PROBLEM=NO PUMP	Sent when the pump is not present
PROBLEM=WRONG PUMP MODE	Sent when the pump is in the incorrect mode for the command.

4.5 Serial Control Setup

Once you have your pumps properly cabled and have your software designed, use the following procedure to put your controller(s) in serial control mode.

To set up for serial control

1. Press the MENU key and select the SERIAL option.
2. Set the unit identification number. Each unit on the network must be set to a unique unit identification number. This pump may be set to be unit number 1 to 7.
3. Set the baud rate for the pump.

> ☑ ***Note***
>
> All units in the network must be set to the SAME baud rate.

If several units are being configured, it is a good idea to place a sticker on the rear of the instrument with the unit number and baud rate listed. This will help identify the unit in the future and prevent assigning the same unit number to two controllers or designating an incorrect baud rate.

HL Series Syringe Pumps

Section 5 Pump Maintenance & Repair

DANGER

RISK OF ELECTRIC SHOCK - DISCONNECT THE ELECTRIC POWER BEFORE SERVICING. ONLY TRAINED SERVICE PERSONNEL MAY REMOVE THE CASE TOP.

DANGER

RISQUE DE CHOC ÉLECTRIQUE. COUPER L´ALIMENTATION AVANT LA RÉPARATION. L´USAGER NE DOIT PAS DÉMONTER L´INSTRUMENT OU DÉRANGER LE MÉCANISME DEDANS. ADRESSER LA REPARATION SEULEMENT AUX TECHNICIENS COMPÉTENTS.

WARNING

ONLY TRAINED SERVICE PERSONNEL MAY PERFORM SERVICE WORK ON THIS EQUIPMENT. FAILURE TO COMPLY WILL RESULT IN SERIOUS RISK TO LIFE AND LIMB, AND WILL VOID THE HAZARDOUS LOCATION CERTIFICATION.

WARNING

Earth ground bonding conductor. Do not remove or disconnect.

Mise à la terre. Ne pas enlever ni déconnecter.

WARNING

Line voltage is present inside this unit at all times, regardless of switch settings. If internal adjustments or repairs are necessary, the line cords must be disconnected to remove possible shock hazard before opening the case.

5.1 Introduction

The following sections contain maintenance and repair procedures which you can do yourself or have done by a technician at your site.

To view the schematics referred to in this section, first find the serial number for your unit. Then go to our Web site at www.isco.com. Select Training and Support and then Product Support. Click on High Pressure Syringe Pumps and then select Schematics in the left margin. After you enter your serial number, you will be able to view the schematics online. If you need any assistance, contact our service department.

5.1.1 Service Department

If you have a question about a procedure, need parts information, or need some help, call the Teledyne Isco Service department. If you write, be sure to include all the details about your instrument and the nature of the error. Address your letter to:

Teledyne Isco, Inc.
Service Department
P.O. Box 82531
Lincoln, NE 68501 USA
IscoService@teledyne.com

We suggest you call the Service Department first, before deciding to return the unit for factory repair. Often a problem can be solved in the field with just a little extra help. Our telephone number is:

Toll free: (800) 775-2965
Outside USA, Canada, and Mexico: (402) 464-0231

5.1.2 How to Ship Returns

In the rare event that an instrument must be returned for maintenance the following measures must be taken to ensure a proper return:

- Teledyne Isco Technical Service (800-775-2965) must be contacted prior to shipment to obtain a clean return form.
- The applicable MSDS paperwork, of the last substance ran, must be received by Technical Service.
- The syringe pump must be shipped with the cylinders removed from the pumps and any residue completely rinsed with methanol or water.
- Wrap the unit in heavy paper or a plastic bag. If the original box is not available, put the wrapped unit in a strong cardboard box at least six inches longer in each basic dimension than the unit.
- Fill the box equally around the unit with resilient packing material.
- Seal it with strapping tape and ship it to the address on the warranty. The warranty at the end of the manual also describes the conditions under which Teledyne Isco will pay surface shipping costs.

NOTICE

· Do not return the pump without contacting the Teledyne Isco Technical Service.

· Do not return the pump without first providing written guarantee that it has been decontaminated of hazardous or potentially lethal materials.

· Teledyne Isco reserves the right to refuse shipment if no decontamination assurance has been provided prior to shipment. Failure to decontaminate a pump may result in legal action taken by state or federal authorities.

Note

It is very important that the shipment be well-packed and fully insured. Damage claims must be settled between you and the carrier. This can delay repair and return of the unit to you.

5.1.3 Removing the Case Top

For some maintenance procedures the case top of the pump component may need to be removed. Use the following procedures:

⚠ DANGER

RISK OF ELECTRIC SHOCK - DISCONNECT THE ELECTRIC POWER BEFORE SERVICING. ONLY TRAINED SERVICE PERSONNEL MAY REMOVE THE CASE TOP.

⚠ DANGER

RISQUE DE CHOC ÉLECTRIQUE. COUPER L´ALIMENTATION AVANT LA RÉPARATION. L´USAGER NE DOIT PAS DÉMONTER L´INSTRUMENT OU DÉRANGER LE MÉCANISME DEDANS. ADRESSER LA REPARATION SEULEMENT AUX TECHNICIENS COMPÉTENTS.

1. Locate and remove the four case top screws on the sides of the instrument, two on each side of the cabinet.
2. Pull the cover straight up and off.

5.2 Lubrication

☑ *Note*

The pump is a precision engineered instrument which must be lubricated after two years or every 6,000 strokes (whichever comes first) to assure proper service life.

The pump has an easy-to-access lube wheel that keeps the main gears lubricated during operation. See Figure 5-1, configuration 1 or 2, depending on your pump motor type. For your convenience, a lubrication kit (containing Never-seez and ALMASOL 609 lubricants) is included in your pump accessory package.

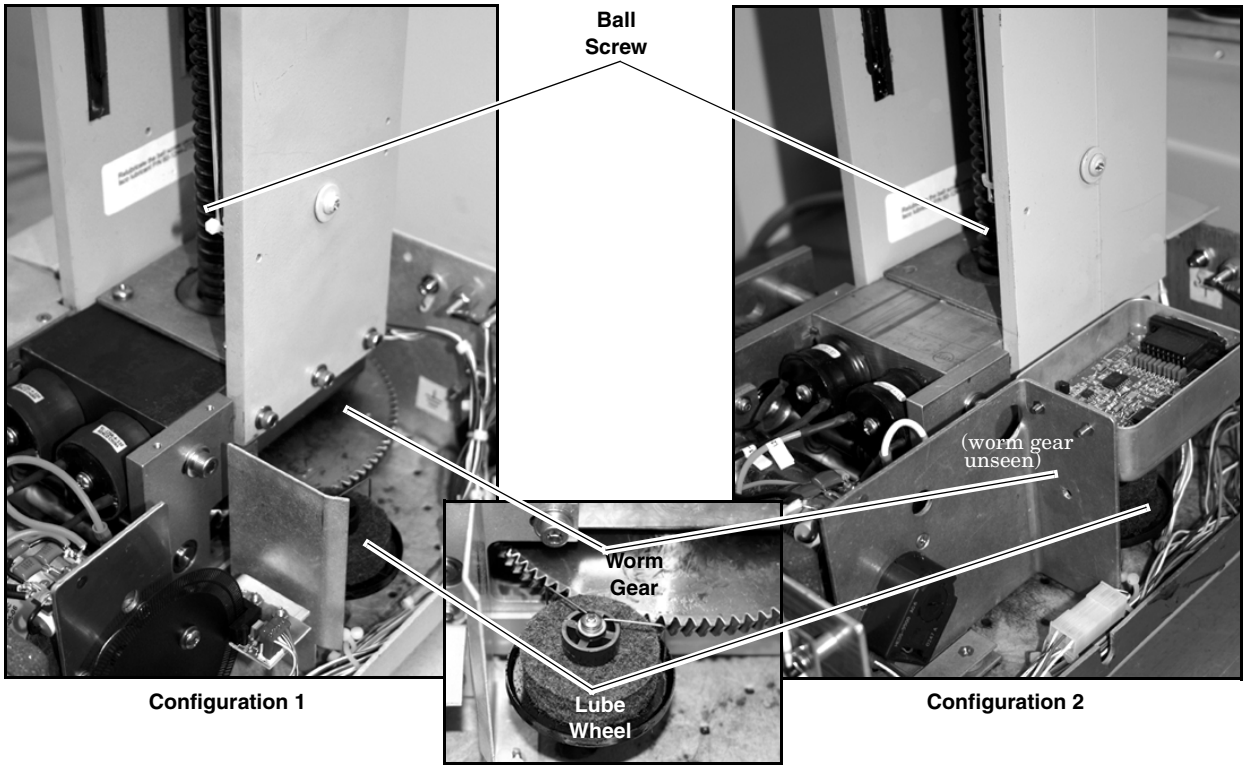


Figure 5-1 Gear train lubrication and motor drive service

Worm / Worm Gear

The worm and worm gear are lubricated by a lubrication wheel. Apply ALMASOL 609 directly to the wheel until it is saturated. The wheel may also be directly lubricated by trickling oil into the wheel while the pump is running.

☑ Note

Use only ALMASOL 609 lubrication on the worm and worm gear. Do not substitute.

5.2.1 Ball Nut

The ball screw, which drives the ball nut, must be kept lubricated with Never-seez.

To lube the worm gear and ball nut
(Figure 5-1)

1. Remove the case top, as detailed in section 5.1.3, and front cover to gain access to all parts requiring lubrication.
2. To lubricate the ball nut, run the pump until the ball nut reaches its maximum height.
3. Apply two beads of lubricant, on opposite sides of the ball screw, down its entire length.

Precision Thrust Bearing

The precision thrust bearing on which the ball screw rides is factory lubricated and should not need re-greasing.

5.3 Seal Cleaning and Replacement

UL (Underwriters Laboratories) has certified the HL Series pumps using only Isco provided seals. **Any substitution of these seals will void the certification.**

For the following instructions, refer to Figure 5-2. Callout numbers in the drawing refer to Model/Part numbers in Table 5-1.

Before cleaning or replacing the piston or wiper seals, the cylinder must first be emptied. To access the cylinder:

1. Run the pump at maximum flow rate until it's empty.
2. Disconnect the power cord.
3. Disconnect the pump pressure transducer cable from the controller and remove the tubing from the inlet and outlet ports.
4. Remove the front cover of the pump.
5. Loosen the four cover screws.
6. Then loosen the cylinder lock screw which is a ¼-20 setscrew located in the front side of the cylinder mounting block.
7. You may now unscrew the cylinder. If you need to use a wrench, we recommend using a strap wrench or the wrenches in the Teledyne Isco wrench package (60-1247-067 for 100HL and 260HL; 68-1247-068 for 500HL; 60-1247-093 for 1000HL), which will not mar the cylinder's outer surface.
8. Once the cylinder has been unscrewed, lift it up and off the piston and the push tube.

The Piston Seal

Sometimes dirt or other solids on the seal can cause leakage. Removing and cleaning the seal may stop the leak and a new seal may not have to be used. However, if you remove and inspect the seal and it does not have any obvious crease or you did not find any foreign material on the seal, then the seal must be replaced. Check the wear ring. See Section 5.5.

⚠ WARNING

If the seals must be replaced, always use Isco-provided seals. Any substitution of seals will void the Hazardous Location certification.

☑ Note

DO NOT use abrasives while cleaning the piston and piston seal area. Scratches caused by the use of such abrasives will cause leaking. If either the cylinder or seal has been scratched, it must be replaced to maintain flow rate specifications.

Accessing the piston seal

1. Unscrew the piston seal retainer (Figure 5-2) from the piston and remove the seal from it. Notice that the spring imbedded in the seal is facing up or is on the top side of the seal.
2. Clean both the piston seal retainer and the cylinder thoroughly. Make sure all parts which come in contact with the seal are free of dirt and other solids.
3. Once the seal and cylinder surfaces have been cleaned, rinse both parts with isopropyl alcohol.

Replacing the piston seal

1. Access the piston seal as previously described.
2. Orient a new seal so that the spring in the seal is facing up.
3. Slide the seal onto the piston.
4. Replace the piston seal retainer.

The Wiper Seal

Although the wiper seal does not normally have to be changed, periodic cleaning is advisable.

1. Access the cylinder as described previously.
2. Locate the piston (Figure 5-2).

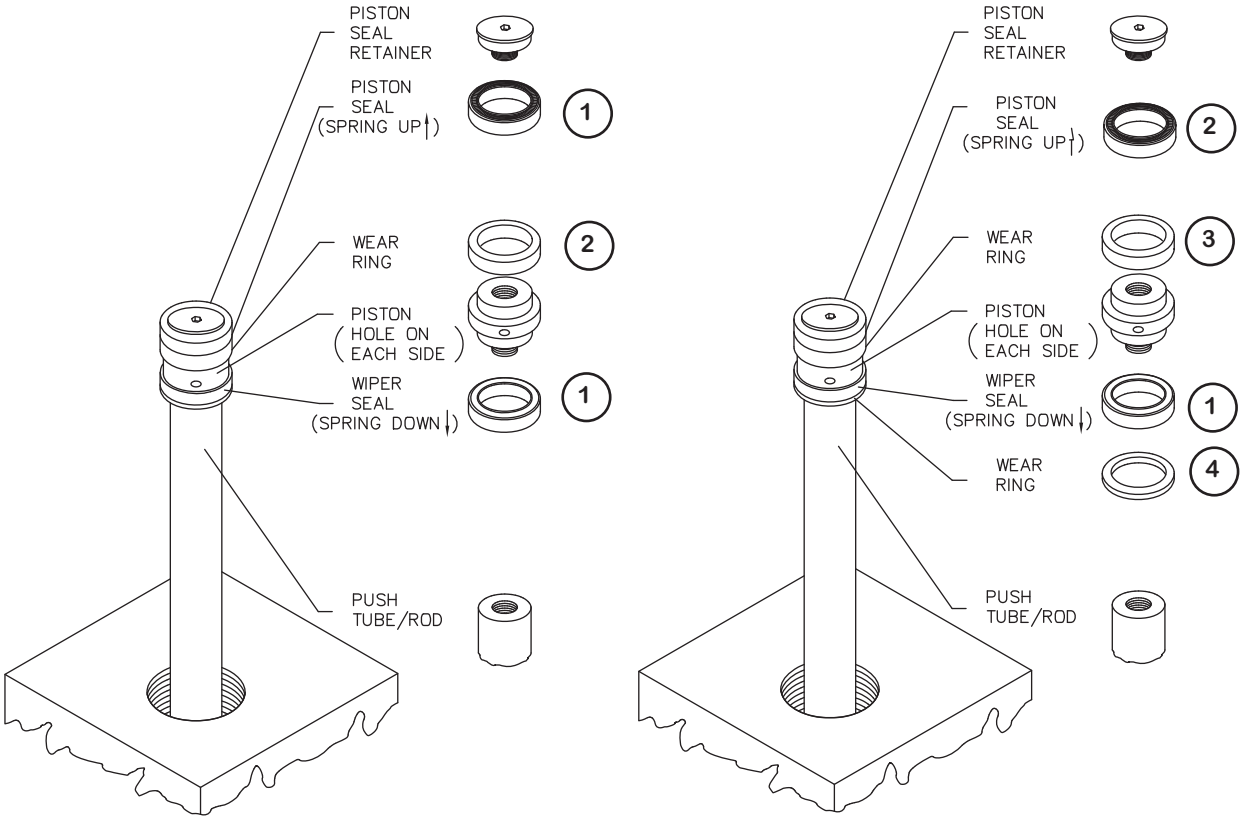


Figure B: 100/260/500HL (see RPL)

Figure A: 1000HL

Figure 5-2 Piston assembly

3. Insert a round, 1/8" diameter steel bar or tool of some sort into the round hole on the side of the piston.
4. Use the tool to twist the piston loose, then unscrew it by hand.
5. Remove the retaining ring and wiper retainer, then lift off the wiper seal. Being careful not to scratch any sealing surfaces, gently break free any solids from the seal and piston. Rinse all the solids away with distilled water.

To reinstall the wiper

1. Install the piston seal onto the retainer with the spring oriented towards the retainer.
2. Install the wiper seal onto the piston base with the spring oriented towards the push tube.
3. Place the piston base onto the push tube.
4. Install the piston seal retainer onto the piston base.
5. Replace the cylinder over the piston and push tube assembly and screw it into the cylinder mounting block. The cylinder should be screwed into the cylinder mounting block until the cylinder snugly bottoms against the piston (the cylinder will no longer turn).
6. Unscrew the cylinder until the inlet and outlet ports are lined up as you had them before.
7. Lock the cylinder by tightening the locking screw. Reinstall covers.

5.4 Replacement Parts List

Table 5-1 lists replacement parts for each model of the HL pump, order numbers, and, where applicable, reference numbers to Figure 5-2.

Table 5-1 HL Pumps Replacement Parts List

Item (Fig. 5-2)	HL Model	Description	Part Number
1	100HL	Piston Seal	202-9090-76
2		Wear Ring	60-1243-536
		Cylinder Cap Seal (Blue)	69-1243-465
		Shear Key	60-1243-608
		Valco – 1/8” Nut	209-0169-27
		1/8” Ferrule	209-0169-41
		1/8” Plug	209-0166-80
		1/8 – 1/16” Internal Reducer (Zero Dead Volume)	209-0169-42

Table 5-1 HL Pumps Replacement Parts List (Continued)			
Item (Fig. 5-2)	**HL Model**	**Description**	**Part Number**
1	260HL	Piston Seal	202-9091-09
2		Wear Ring	60-1243-537
		Cylinder Cap Seal (Blue)	69-1243-444
		Shear Key	60-1243-607
		Valco – 1/8" Nut	209-0169-27
		1/8" Ferrule	209-0169-41
		1/8" Plug	209-0166-80
		1/8 – 1/16" Internal Reducer (Zero Dead Volume)	209-0169-42
1	500HL	Piston Seal	202-9093-56
2		Wear Ring	601243-538
		Cylinder Cap Seal (Blue)	69-1243-455
		Shear Key	60-1243-654
		1/8" Conn. To 1/8" NPT	209-0161-01
		1/8" NPT Plug	209-0168-05
		1/8 – 1/16" Tubing Reducer	209-0162-00
1	1000HL	Lower Piston Seal	202-9990-27
2		Upper Piston Seal (with lip)	202-9990-28
3		Wear Ring (upper)	60-1243-776
4		Wear Ring (lower)	60-1243-809
		Cylinder Cap Seal (Blue)	69-1243-779
		Shear Key	60-1243-607
		¼" Tubing Connector	209-0163-36
		¼" NPT Plug	209-0168-09
1/16" OD X 0.007 ID		Stainless Steel Tubing	004-7300-23
1/16 OD X 0.009" ID		Stainless Steel Tubing	004-7462-51
1/16 OD X 0.020" ID		Stainless Steel Tubing	004-7300-21
1/8 OD X 0.069" ID		Stainless Steel Tubing	004-7302-22
1/4 OD X .180 ID		Stainless Steel Tubing	004-7302-51

5.5 Wear Ring Cleaning and Replacement

Although the wear ring does not routinely need to be replaced, occasionally it becomes worn or damaged, depending on how the pump has been used. Teledyne Isco recommends that when replacing the seal or cleaning the piston, check the wear ring for any signs of deterioration.

To replace the wear ring

1. Follow the instructions in section 5.3, Seal Cleaning and Replacement, to access the cylinder.
2. Remove the piston seal retainer and slide off the seal. The wear ring should then slide easily up and off the piston.

The wear ring prevents the piston from direct metal-to-metal contact with the cylinder wall, and should, therefore, extend at least 0.010" beyond the circumference of the piston lip. Check the bottom of the wear ring, which rests on the piston lip, for extrusion or any unevenness. If there is an indentation (of 0.0010" or more) marking the outline of the piston lip, then you should replace the wear ring. However, if the surface is smooth, the wear ring does not need replacing.

5.6 Flushing the Cylinder

After cylinder/seal maintenance or during modifier (liquid solvent) change, the pump cylinder should be flushed to remove possible residue.

The way in which the cylinder is flushed will depend on your pumping system and whether you are pumping a liquefied gas such as CO_2 (see section 5.6.1) or a liquid modifier such as methanol (see section 5.6.2).

5.6.1 Gas Solvent Changeover

This procedure is used when changing from one gaseous solvent to another.

To switch gas solvents

1. Close the valve on the fluid supply tank so that no solvent is supplied to the system.
2. Turn the controller ON.
3. Open the pump outlet valve. If there was any pressure in the system, wait until all the pressure bleeds off.
4. Change the solvent tank.
5. Close the pump outlet valve.
6. Open the valve on the tank to repressurize the system.
7. Refill the pump, if necessary.

5.6.2 Liquid Solvent Changeover and Flushing

This procedure is typically used for modifier systems when changing from one liquid solvent to another.

☑ *Note*

If high ionic strength aqueous reagent solutions are allowed to remain in the pump, solid residues may be formed, which will scratch the seals and the polished inner surface of the cylinder of the pump. These scratches allow leakage, which decreases flow rate.

To clean the cylinder

1. Press the CONST FLOW key on the front panel of the controller.
2. Press the RUN key. You will be asked to designate which pump if more than one is present.
3. Press a softkey to run the desired pump.
4. Run the pump until the message “CYLINDER EMPTY” is displayed.
5. Place the pump inlet line in a flask containing a compatible solvent or a detergent solution.
6. Press the blue REFILL key.
7. You will be asked to designate the pump to refill if more than one is present. Press a softkey to refill the pump.
8. Fill the pump and repeat this procedure several times.
9. Then place the pump inlet line in a flask containing distilled water or appropriate solvent. Fill the pump once more and then run it until empty. You are now ready to fill the pump with your new liquid solvent.

☑ Note

Do not leave buffer solutions which contain dissolved salts or are corrosive in the cylinder, overnight or for long periods of time. The pump should be stored with methanol or isopropanol (at least partially fill the cylinder with either solvent and then run the piston all of the way up) when it is not being used.

5.7 General Cleaning

For general cleaning of the instrument’s front panel or enclosure, use a mild detergent in water or isopropyl alcohol on a sponge which is mostly squeezed out.

5.8 Torque Limiter

There are two torque limiting devices on the pump. An indirect torque limiter is controlled by the operator of the pump. The operator can set the maximum pressure limit on the pump controller. (When the pressure exceeds the maximum pressure setting, the pump is stopped electronically).

The second torque limiting device is a shear key in the worm gear assembly of the pump. Should the maximum pressure circuit fail and excessive pressures (pressures that exceed maximum pressure limits) persist in the operation of this pump, the torque limiting shear key may become damaged. The shear key will yield at pressures slightly above maximum pressure, and it will break around 1.5 times the pressure rating.

In the event of a shear key failure, the pump will sound as though it is turning, but the piston will not be advancing up the cylinder. Damage to the cylinder cap and push tube could be possible if the key failed due to extreme overpressure.

5.9 Shear Key Replacement

For shear key replacement, refer to Figure 5-3 A, B, C, and D, and Table 5-1 *HL Pumps Replacement Parts List*.

To replace the shear key

1. Place the pump on its side and remove the four panhead screws (shear key), that attach the access plate to the case bottom, as shown in Figure 5-3A.
2. Remove the cotter pin which passes through the castle nut and ball screw.
3. Use a ¾" wrench to remove the castle nut, shown in Figure 5-3B.
4. Remove the spacer.
5. The two broken halves of the shear key should be protruding from the brass worm gear and the ball screws.

5.9.1 Shear Key Installation Tool

To replace the shear key using the shear key installation tool (P/N 60-1248-135)

1. Insert tool into ball screw such that the slot on ball screw and tool are lined up, then lock with locking pin.
2. Rotate the ball screw until the broken halves of shear key are realigned (Figure 5-3C).
3. Remove the broken shear key halves by gripping them with pliers or vise grips and pulling them out.
4. Insert the new shear key into the slot as shown in Figure 5-3C. (The shear key should go into the brass worm approximately ⅛". Do not push it all the way in).
5. Remove the tool.
6. Slide the spacer onto the ball screw. Install the castle nut on the ball screw. If the shear key isn't completely in the slot, the spacer will position it properly as the castle nut is tightened.
7. Tighten the castle nut as tight as you can. Then loosen the nut until it can be turned by hand. Tighten the nut finger tight.
8. Insert the cotter key through the castle nut and ball screw. If the holes do not line up, tighten the castle nut until any set of holes allow the cotter pin to be inserted.
9. Reinstall the access cover.

To replace shear key without the shear key installation tool

1. Follow steps 1 through 5 in section 5.9.
2. Insert the cotter pin into the ball screw, and screw the castle nut onto ball screw, with the slot on castle nut outward, as shown in Figure 5-3D.
3. Use a ¾" wrench on castle nut and rotate the ball screw clockwise until the broken halves of shear key are realigned.
4. Remove the castle nut and cotter pin.

5. Remove the broken shear key halves by gripping them with pliers or vise grips and pulling them out.
6. Insert the new shear key into the slot. (The shear key should go into the brass worm gear approximately $\frac{1}{8}$". Do not push all the way in.)
7. Follow steps 6 through 9 above.

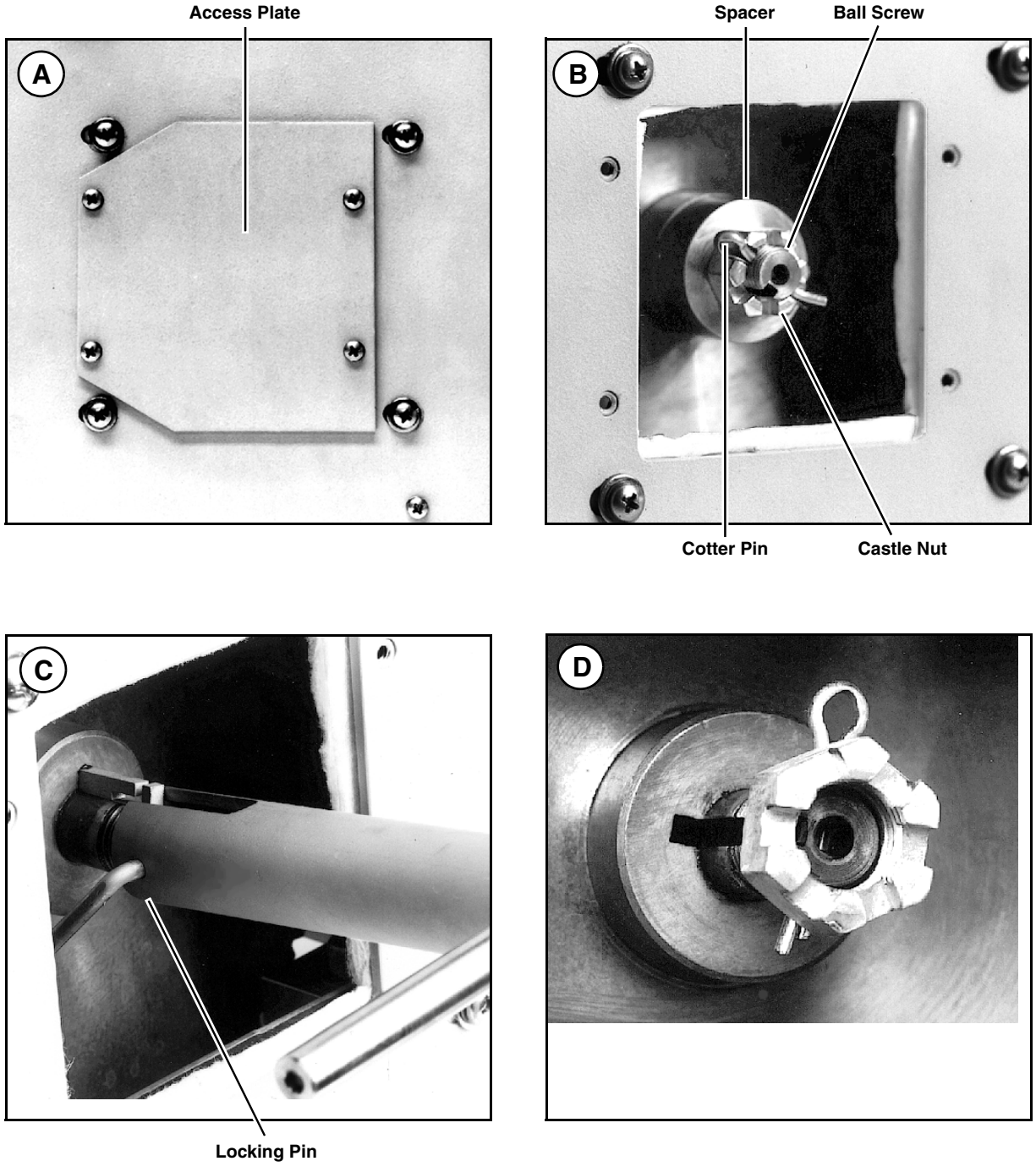


Figure 5-3 Shear key replacement

HL Series Syringe Pumps

Section 6 Continuous Flow Introduction, Installation, & Operation

6.1 Introduction

An HL Series continuous flow pumping system consists of two syringe pumps and a valve accessory package regulated by one controller. This system allows you to continuously deliver your liquefied gas or liquid under constant flow or constant pressure mode.

Continuous flow can be used in either of two modes: continuous constant pressure or continuous constant flow. Both of these modes assume positive displacement of the piston.

In any syringe pump continuous flow system there is a flow irregularity which occurs at the time of switchover from one pump module to the other. This flow irregularity can be measured as a pressure fluctuation. Isco pressure fluctuation at switchover is ~0.35 bar (at system backpressures from 6.9 bar to the single pump maximum).

Before programming continuous flow, appropriate valves must be connected, the pumps must contain fluid, and there must be backpressure for operation.

6.2 Valve Plumbing Suggestions

The following section describes the installation procedure for continuous flow check valves, continuous flow valves, and user selected valves.

Table 6-1 Specifications	
Pressure fluctuation at switchover	0.35 bar, at system backpressures from 6.9 bar to the single pump maximum. Higher fluctuation occurs at pressures below 6.9 bar.
Minimum	3.5 bar
Maximum system backpressure	The single pump maximum. Valves rated to 689.5 bar
Maximum flow rate	
Liquids	65% of the single pump maximum rate, *e.g.*, System A260- will deliver up to 58 ml/min at 275.8 bar backpressure and 40 ml/min at 517.1 bar.
Liquefied gases	45% of the single pump maximum rate. Cylinder cooling jackets should be used to obtain this rate.
Temperature range	0 to 40°C
Wetted materials in valve packages:	
Air valves	Hastelloy, PEEK, and Teflon (5.5 - 7.9 bar air pressure required)
Check valves	SS316, sapphire, ruby, PEEK, Teflon
Tubing and fittings	SS316, gold

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

6.2.1 Continuous Flow Check Valve Package Plumbing Suggestions

The continuous flow package (P/N 68-1247-059), detailed in Table 6-2, connects two HL-Series syringe pumps, allowing continuous flow operation. The tees, check valves, and connecting tubing come assembled so that you can quickly and easily install this package in your system. For additional convenience, the two lengths of pump connection tubing come with the fittings already attached. The only connections you have to make are between the pump tubing and the double check valve housings and between the outlet and inlet tubing and the tees.

Figure 6-1 Check valve package installation

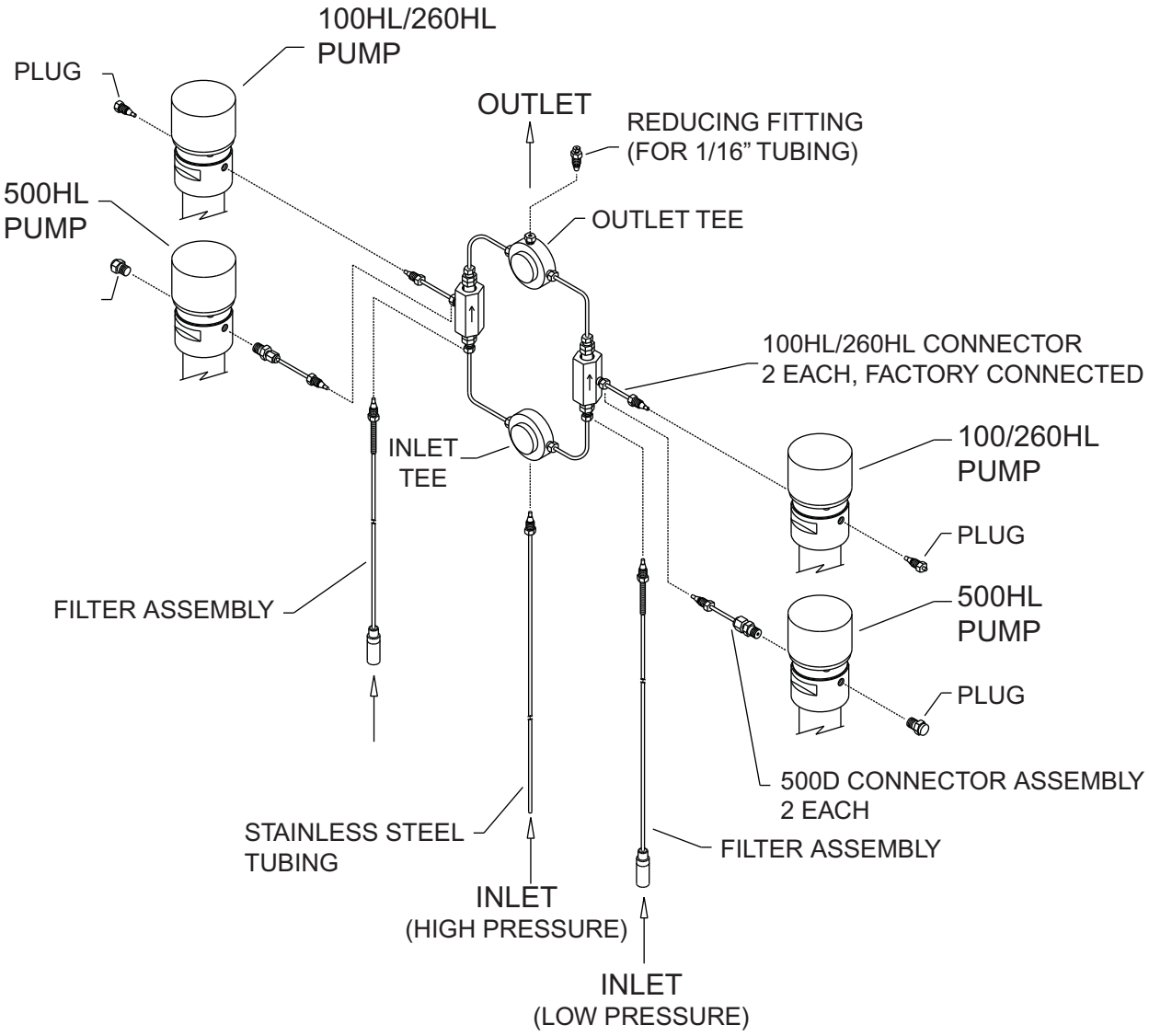


Table 6-2 Continuous Flow Check Valve Package (68-1247-059)

Qty.	Part Number	Description
18	209-0169-41	1/8" ferrule
10	209-0169-27	1/8" nut
2	209-0168-05	1/8" pipe plug
2	209-0166-80	1/8" plug assembly
4	60-2253-240	Check valve housing, analytical standard inlet
4	60-3864-010	Check valve cartridge
4	60-1243-519	6.4 cm × 2.5" tubing
4	60-1243-518	6.4 cm tubing
1	60-1243-391	1.5 m - 0.125" tubing
2	60-1243-557	1.5 m - 0.085 ID Teflon tubing
2	60-1243-517	Double check valve housing
2	209-0161-01	0.12" male connector
2	209-0161-36	Tee union for 1/8" OD tubing
1	209-0169-42	Reducing tubing connector 1/8" to 1/16"
2	60-2258-019	Nut assembly
2	209-0169-81	Male nut for 1/8" tubing
2	209-0169-80	10 µ replacement filter

Inlet Tubing

There are two types of inlet tubing provided with this kit. The stainless steel tubing is to be used for a pressurized inlet source, the Teflon tubing may be used if the source is not pressurized.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

To install the check valve package

☑ *Note*

Tighten fittings just enough to hold tubing in place. Final tightening will be done after all the tubing and fittings are in place.

1. Move the pumps so that the pump bases are about 1.3 cm apart.
2. Use the plugs to stopper the ports which will not be connected to the continuous flow package.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

3. Attach the connectors appropriate to your pump to the 6.4 cm unbent stainless steel tubing lengths and use the 1/8" nuts and ferrules to attach to the double check valve housings.
4. Attach the inlet tubing assembly. The tubing you use depends upon whether or not your source is pressurized.
   a. Pressurized Reservoir:
   Connect the 1/8" × 1.5 m stainless steel tubing to the bottom of the inlet tee, using high pressure valve fittings.

☑ *Note*

The filter and Teflon tubing are not used.

   b. Nonpressurized Reservoir:
   Connect the 1/8" × 1.5 m Teflon tubing to the bottom of each inlet check valve using the ferrule and nut with support spring provided in the package. Attach the tubing to the filter connector and then connect the filter.

☑ *Note*

The stainless steel tubing is not used.

5. Once the contents of the continuous flow package are totally assembled, attach the connectors appropriate for your pump on one side of the assembly to a port. Then, supporting the tee/valve assembly attach the other connector to the port of the second pump.
6. Attach the outlet fittings to the top of the upper tee. Fittings for 1/8" tubing, as well as an optional reducing fitting for 1/16" tubing, are provided. Use the fittings appropriate for your tubing size.

You may now tighten all the fittings.

6.2.2 Continuous Flow Air Valve Plumbing Suggestions

Only continuous flow air valves may be used with HL Series Pumps.

Air Valve Package Numbers

The continuous flow air valve package for Model 100HL and 260HL pumps is catalog #68-1247-058. For Model 500HL syringe pumps, order catalog #68-1247-061. For Model 1000HL pumps, order catalog #68-1247-104.

☑ *Note*

Air valve package 68-1247-058 is included in Systems A260, A100M, and A100X. Air valve package 68-1247-061 is included in System A500.

To connect an air valve package
(Figure 6-2)

1. Position the valve bases 1.3 cm apart.
2. Use the plugs to stopper the ports which will not be connected.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

3. Loosely attach the tubing lengths from the valve assembly to the pumps.
4. Allow the bracket to hang vertically and place the straps around the pressure transducer caps. Tighten the wing-nuts.
5. Install the four bracket panhead screws on the bottom of the bracket.

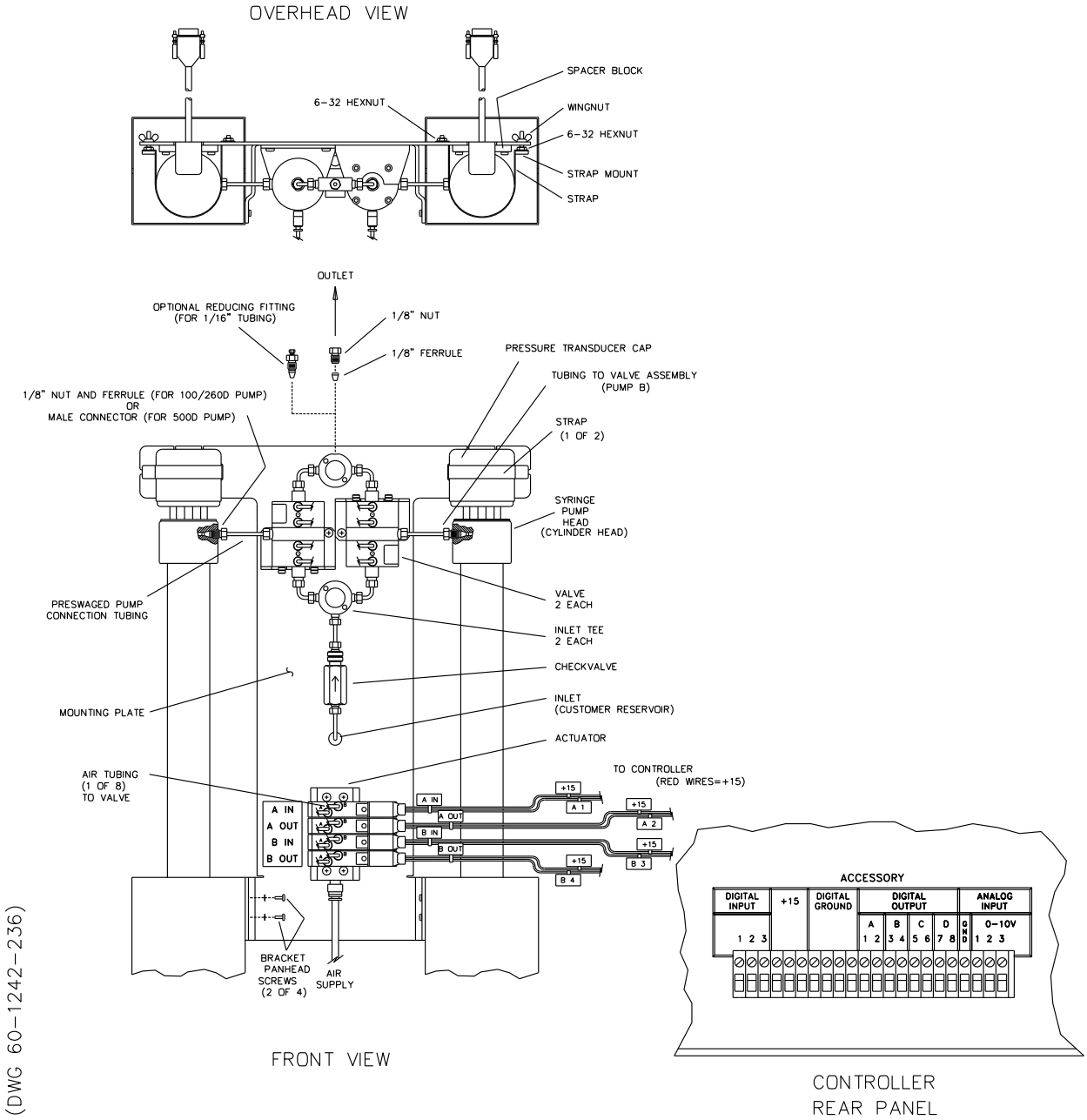
To make the plumbing connections

1. Tighten the tubing nuts.
2. Connect the inlet tube to the supply reservoir. Connect the outlet tee to your apparatus.

To make the electrical connections

1. Connect the wiring as shown in Figure 6-2.

Figure 6-2 Air valve installation



6.2.3 User Supplied Valves

Users may also choose to supply their own valves.

⚠ CAUTION

If the HL series pump is operated in a hazardous location, user-supplied valves must be UL approved for use.

The following information is necessary to choose the appropriate valves to work with Isco Continuous Flow software.

- Check valves

  Do not use spring loaded check valves if refilling at atmospheric pressure; the pump seals are not designed to draw against a vacuum. The balls in Isco check valves are closed by gravity.

- Powered valves

  These are electrically triggered from the pump controller and could be air or electrically actuated. Digital outputs 1-4 provide signals for control of four two-way valves. One wire for each valve is connected to its specific connector on the rear of the controller. A second wire for each valve connects to ground. The signal provided is an open collector which functions as a switch open for closure of the fluid path. A switch closure (low) signals opening of the fluid path.

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

Table 6-3 presents the relationship between the digital output, pump valve location and the fluid path status for the "ACCESS CTRL" connections. Refer to the accessory control connections on the rear panel of the pump controller.

Table 6-3 Accessory Control Digital Outputs

Digital Output	Pump Valve Location	Fluid Path Status
1	A	Inlet (open or closed)
2	A	Outlet (open or closed)
3	B	Inlet (open or closed)
4	B	Outlet (open or closed)

Alternate connections can be made to drive low power 12-15 V relays or electric valves. Assume two wires per relay or valve. The first wire is connected to the appropriate digital output on the back of the pump controller. The second wire can be connected to the +15 V connector, to supply a maximum of 200 mA for switching of relays or valves. Observe correct polarity if the valve or relay is polarized.

6.3 Operation

Once your valve package has been properly installed and you have insured that fluid connections are leak free, you are ready to begin operating your system.

> ☑ ***Note***
>
> Isco convention is to name the pumps “pump A” and “pump B,” reading from left to right.

Before running in continuous flow mode, become familiar with independent mode, which allows the controller to operate two pumps independently and simultaneously. You must operate the two pumps manually for initial setup, *i.e.* refill and purging of air. If the Isco air valve package is used, the air valves are switched through the “ACCESS CTRL” key. Lights on the air switches indicate which valves are open.

6.3.1 Setting Up Continuous Flow

Continuous flow mode is found under the multi-pump options on the second page of the main menu (MORE). Once you have accessed the multi-pump options you may select continuous flow - constant flow mode or constant pressure mode.

To set up continuous constant flow

1. Press the orange MENU key on the controller front panel.
2. Press softkey A, MORE, to access the second page of the main menu.
3. Press the 4 key on the numeric keypad to select number 4. MULTI-PUMP. The multi-pump menu will then be displayed.
4. Press the 1 key on the numeric keypad to select 1. CONTIN CONST FLOW. The 1. will blink, indicating that the controller is set to this mode.
5. Press softkey D, PREVIOUS, three times to return to the run screen.

The controller has now automatically set the pump to continuous constant flow mode.

To set up continuous constant pressure

1. Press the orange MENU key on the controller front panel.
2. Press softkey A, MORE, to access the second page of the main menu.
3. Press the 4 key on the numeric keypad to select number 4. MULTI-PUMP. The multi-pump menu will then be displayed.
4. Press the 2 key on the numeric keypad to select 2. CONTIN CONST PRESS. The 2. will blink indicating that the controller is set to this mode.
5. Press softkey D, PREVIOUS, three times to return to the run menu.

The controller is now set to continuous constant pressure mode.

6.3.2 Continuous Flow Features

The following features are used to define your continuous flow operation.

Volume Totalizer

The total volume delivered (in liters) is given on the display at the right top corner.

To reset the volume totalizer to zero

1. Press the orange MENU key on the controller front panel.
2. Press softkey A, MORE, to access the second page of the main menu.
3. Press 5 on the numeric keypad to select 5. TOTAL VOLUME RESET.
4. Press softkey D, PREVIOUS, twice to return to the run screen. The displayed volume will be zero.

Valve Specification

It is important to specify in the menu the type of valve package being used for continuous flow. This will assure minimum pressure fluctuation at switchover.

To specify valves installed

1. Press the orange MENU key on the controller front panel.
2. Press softkey A, MORE, to access the second page of the main menu.
3. Press 6 on the numeric keypad to select 6. VALVE.
4. Press 1 or 2 on the numeric keypad to specify Active (air actuator) or Passive (check valves) installed.
5. Press softkey D, PREVIOUS, three times to return to the run screen.

6.4 Operating Tips and Guidelines

The following tips and guidelines are provided by our research laboratory. Please familiarize yourself with them before operating your continuous flow system.

- Temperature changes can cause pressure fluctuations, especially if a restrictor is being used for backpressure.
- Pressure limits for continuous constant flow mode are set by the limits of pump A.
- For correct overpressure response, overpressure shutdown must be set to shutdown “ON” under pump limit options.
- Always check the flow rate before pressing the RUN key, especially after using the pump in a mode other than continuous flow. For example, a flow rate can be carried over from independent mode control of pump A.
- Refill rates: As a rule of thumb, the refill rate should be at least twice the flow rate setpoint (in continuous constant flow) to allow time for refill and repressurization before the next switchover. The same refill rate should be entered separately for pumps A and B.

Operational Overview – When using liquids

1. Degas liquids if appropriate.
2. Fill both pumps completely.
3. Zero pressure in each pump (requires valves open to atmosphere).
4. Purge air.

5. Perform the total volume reset operation, as previously described.
6. Be sure "ON CONT FLOW" is displayed on the screen.
7. When the pumps start delivering, the system will go through an equilibration phase. To properly equilibrate the pumps, they must be full and delivering fluid during equilibration phase.
8. Press the RUN key.

Operational Overview – When using liquefied gases

1. Zero pressure in each pump if empty (valves must be open to atmosphere).
2. Fill both pumps completely.
3. Pressurize both pumps.
4. Perform the total volume reset operation.
5. Be sure "ON CONT FLOW" is displayed on the screen.
6. Press the RUN key.

6.5 Special Features

The following special features may be useful for your continuous flow applications.

6.5.1 Remote Start/Stop

The HL Series syringe pump can be externally started or stopped by switch contact closure or TTL input. The TTL input voltage is 5 volts and is internally pulled high (RUN). The input is level sensitive and must remain High for RUN and Low for STOP.

The control wire should be connected to terminal 1, and the common wire should be connected to digital ground. To use the remote RUN/STOP feature, first press RUN or force the Run/Stop pin low and then high to start the pumps. Thereafter, the Run/Stop pin will control operation. Pressing STOP on the front panel will override the Run/Stop pin.

6.5.2 External Analog Control

Flow or pressure setpoints can be externally controlled by analog voltage. Two wires are required for analog control. The analog common or ground wire should be connected to the GND terminal under ANALOG INPUT, and the analog control signal (or input) should be connected to terminal 1 under ANALOG INPUT. For more information, see section 3.6 of this instruction manual.

6.5.3 Serial Control and Monitoring

The pumps can be externally controlled with a computer which has an RS-232-C serial output. The serial interface accepts English command words from the computer, like constant pressure, refill, etc. For more information, see Section 4, Serial Interface.

6.6 Accessories

Isco offers a temperature control jacket (68-1247-057) for the Model 500HL. Temperature control jackets are compatible with continuous flow valve packages and may be needed, for example, for barrel cooling when pumping a liquefied gas. Isco Continuous Flow systems do not include temperature control jackets.

Insulation covers are not compatible with continuous flow valve packages and should not be needed with the flow rates used in continuous flow.

For information on other accessories please contact Isco:

(800) 228-4250 or (402) 464-0231

HL Series Syringe Pumps

Section 7 Analog/Serial Control

7.1 Remote Start/Stop External Analog Control Series

The HL Series syringe pump RUN/STOP function can be externally controlled by switch contact closure on TTL input. The input voltage is 5 volts and is internally pulled high (RUN). The input is level sensitive and must remain High for RUN and Low for STOP.

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

The control wire should be connected to terminal 1 and the common wire should be connected to digital ground. To use the remote RUN/STOP feature, first press RUN or force the Run/Stop pin low and then high to start the pumps. Thereafter, the Run/Stop pin will control operation. Pressing STOP on the front panel will override the Run/Stop pin.

7.2 External Analog Control

The pumps can be externally controlled by analog voltage. Two wires are required for analog control. The analog common or ground wire should be connected to the GND terminal under ANALOG INPUT and the analog control signal (or input) should be connected to terminal 1 under ANALOG INPUT. For more information, see section 3.6 of the instruction manual.

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

7.3 Serial Control

The pumps can be externally controlled with any IBM-PC or compatible which has RS-232-C serial output. The serial interface accepts English command words from the computer like constant pressure, refill, etc. For more information, see Section 4, *Serial Interface*.

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

HL Series Syringe Pumps

Index

产品中有毒有害物质或元素的名称及含量

Name and amount of Hazardous Substances or Elements in the product

部件名称 Component Name	有毒有害物质或元素 Hazardous Substances or Elements					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二联苯 (PBDE)
电源开关 Power Switch	X	O	O	O	X	O
步进电机 Stepper Motor	X	O	O	O	X	O
线路板 Circuit Boards	X	O	O	O	O	O
液晶显示 LCD Display	X	O	O	O	O	O
接线 Wiring	O	O	O	O	X	O
内部电池 Internal Battery	O	O	O	O	X	O
外部电池 External Battery	O	O	O	O	X	O
主电源线 Line Cord	O	O	O	O	X	O
变压器 Transformer	X	O	O	O	X	O
前面板标志 Front Panel Label	X	O	O	O	O	O
小键盘 Keypad	X	O	O	O	X	O

产品中有毒有害物质或元素的名称及含量：Name and amount of Hazardous Substances or Elements in the product

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在ST/ 标准规定的限量要求以下。

O: Represent the concentration of the hazardous substance in this component's any homogeneous pieces is lower than the ST/ standard limitation.

X：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出ST/ 标准规定的限量要求。

(企业可在此处，根据实际情况对上表中打"X" 的技术原因进行进一步说明。)

X: Represent the concentration of the hazardous substance in this component's at least one homogeneous piece is higher than the ST/ standard limitation.

(Manufacturer may give technical reasons to the "X"marks)

环保使用期由经验确定。

The Environmentally Friendly Use Period (EFUP) was determined through experience.

生产日期被编码在系列号码中。前三位数字为生产年(207 代表2007年) 。随后的一个字母代表月份：A为一月，B为二月，等等。

The date of Manufacture is in code within the serial number. The first three numbers are the year of manufacture (207 is year 2007) followed by a letter for the month. "A" is January, "B" is February and so on.

DECLARATION OF CONFORMITY

CE
ISM1-A

Application of Council Directive:	89/336/EEC – The EMC Directive 73/23/EEC – The Low Voltage Directive 94/9 EC - The ATEX 100a Directive
Manufacturer's Name:	Teledyne Isco, Inc.
Manufacturer's Address:	4700 Superior, Lincoln, Nebraska 68504 USA Mailing Address: P.O. Box 82531, Lincoln, NE 68501
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments: The devices are HL Series syringe pumps consisting of a motor driven pump cylinder, a power supply (electrical components) housed inside a metal enclosure (base) and electronic control printed circuit board assemblies housed inside a metal enclosure. The devices are intended for operation in ambient temperature range of 5 to 40 C.
Trade Name/Model No:	Series 65HL, 65HLX, 100HLM, 100HLX, 260HL, 260HLX, 500HL, 500HLX, 1000HL, 1000HLX
Year of Issue:	2003
Standards to which Conformity is Declared: ***DEMKO Certificate No. :03ATEX0239110X***	EN 50021 Electrical Apparatus for Potentially Explosive Atmospheres – Type of protection "n" EN 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use EN 61326-1998 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	A A
EN61000-4-3	Radiated RF Immunity	80 MHz to 1000MHz 80% AM at 1kHz Level 1 – 1V/m	A
EN61000-4-4	Electrical Fast Transient	Level 2 - 1kV on AC lines	A
EN61000-4-5	Surge on AC Lines	Level 2 -1kV common mode, Level 2 - 0.5KV differential mode	A
EN61000-4-6	Conducted RF on AC lines	150 kHz to 80 MHz, Level 1 - 1V rms, 80% modulated	A
EN61000-4-11	Voltage Dips/Short Interruptions	0.5 cycle, each polarity/100%	A
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	
EN61000-3-2, 3-3	Harmonic and Flicker		

We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of June 1, 2003.

William Foster
USA Representative

TELEDYNE ISCO
A Teledyne Technologies Company

William Foster
Director of Engineering
Teledyne Isco, Inc.
4700 Superior Street
Lincoln, Nebraska 68504
Phone: (402) 464-0231
Fax: (402) 464-4543

60-1262-022
Rev D

Teledyne Isco One Year Limited Factory Service Warranty*

This warranty exclusively covers Teledyne Isco instruments, providing a one-year limited warranty covering parts and labor.

Any instrument that fails during the warranty period due to faulty parts or workmanship will be repaired at the factory at no charge to the customer. Teledyne Isco's exclusive liability is limited to repair or replacement of defective instruments. Teledyne Isco is not liable for consequential damages.

Teledyne Isco will pay surface transportation charges both ways within the 48 contiguous United States if the instrument proves to be defective within 30 days of shipment. Throughout the remainder of the warranty period, the customer will pay to return the instrument to Teledyne Isco, and Teledyne Isco will pay surface transportation to return the repaired instrument to the customer. Teledyne Isco will not pay air freight or customer's packing and crating charges. This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

The warranty for any instrument is the one in effect on date of shipment. The warranty period begins on the shipping date, unless Teledyne Isco agrees in writing to a different date.

Excluded from this warranty are normal wear; expendable items such as charts, ribbon, lamps, tubing, and glassware; fittings and wetted parts of valves; and damage due to corrosion, misuse, accident, or lack of proper maintenance. This warranty does not cover products not sold under the Teledyne Isco trademark or for which any other warranty is specifically stated.

No item may be returned for warranty service without a return authorization number issued by Teledyne Isco.

This warranty is expressly in lieu of all other warranties and obligations and Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

The warrantor is Teledyne Isco, 4700 Superior, Lincoln, NE 68504, U.S.A.

*** This warranty applies to the USA and countries where Teledyne Isco does not have an authorized dealer. Customers in countries outside the USA, where Teledyne Isco has an authorized dealer, should contact their Teledyne Isco dealer for warranty service.**

Before returning any instrument for repair, please call, fax, or e-mail the Teledyne Isco Service Department for instructions. Many problems can often be diagnosed and corrected over the phone, or by e-mail, without returning the instrument to the factory.

Instruments needing factory repair should be packed carefully, and shipped to the attention of the service department. Small, non-fragile items can be sent by insured parcel post. **PLEASE BE SURE TO ENCLOSE A NOTE EXPLAINING THE PROBLEM.**

Shipping Address:	Teledyne Isco - Attention Repair Service 4700 Superior Street Lincoln, NE 68504 USA
Mailing Address:	Teledyne Isco PO Box 82531 Lincoln, NE 68501 USA
Phone:	Repair service: (800) 775-2965 (lab instruments) (866) 298-6174 (samplers & flow meters) Sales & General Information: (800) 228-4373 (USA & Canada)
Fax:	(402) 465-3001
Email:	IscoService@teledyne.com

February 28, 2012 P/N 60-1002-040 Rev G

TELEDYNE ISCO
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