HL_f Series Syringe Pumps

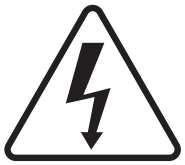
Installation and Operation Guide

TELEDYNE ISCO
Everywhereyoulook™

Part #69-1243-968 of Assembly #60-1243-997

Rev. D, October 2023

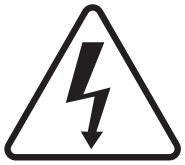
Warnings and Cautions



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.

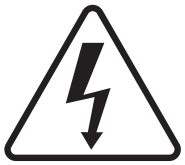
Symboles de Sécurité



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

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

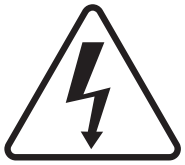
Warnungen und Vorsichtshinweise



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!

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_f Pumps

⚠ WARNING

Pumping fluids that are not compatible with the HL_f 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_f 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	

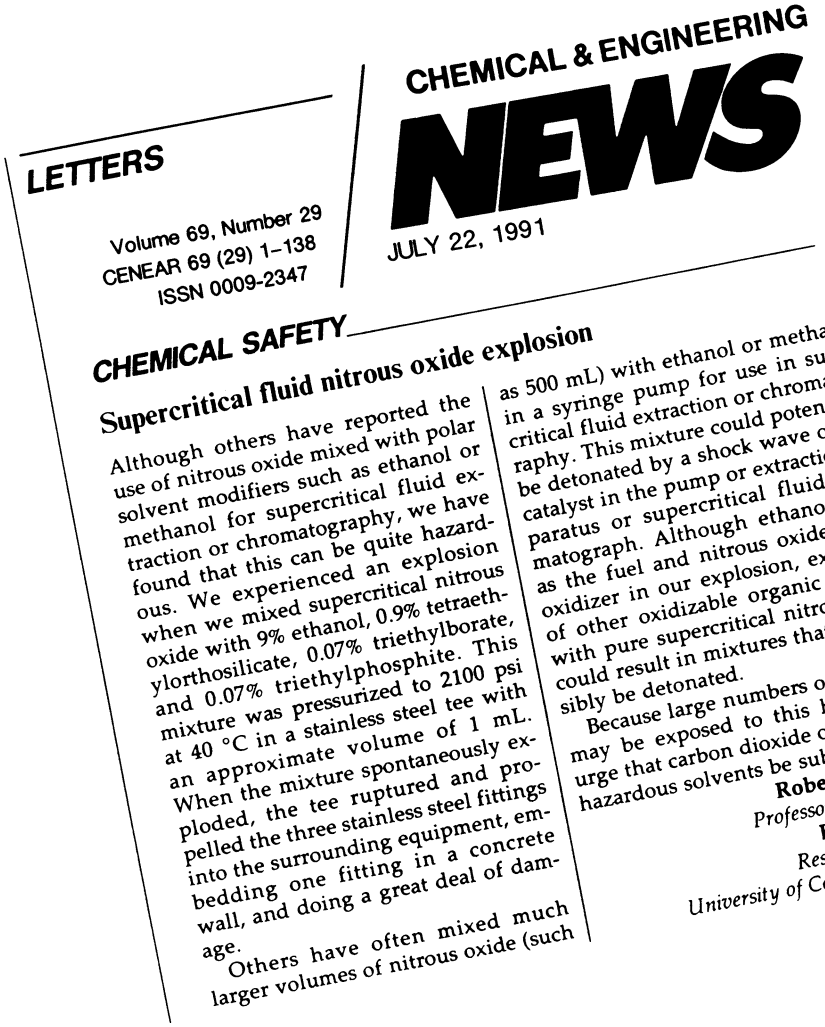
Consult with Isco before using any chemical not listed above.

WARNING:
PLEASE READ

At the request of our Supercritical Fluid Extraction laboratory staff, we want our customers to be aware of the potential hazards involved with supercritical fluid extraction. Oxidizing gases, such as nitrous oxide, in contact with organic matrices or flammable modifiers, can detonate under certain conditions. Likewise, flammable fluids, such as methane, under high pressure conditions can present a hazard.

With concern for the safety of our customers, we have designed our extractors to be as safe as possible. However, we do not recommend the use of our instrument with potentially explosive reactions.

The letter below, which appeared in the July 22, 1991 edition of Chemical and Engineering News, is reprinted with permission from Professor Robert E. Sievers and his colleagues at the University of Colorado at Boulder. Even though they were not performing supercritical fluid extraction, it details the problems their lab experienced using nitrous oxide under similar conditions. We add our support for their suggestion to use only carbon dioxide or other less hazardous fluids for supercritical fluid extraction.



LETTERS

CHEMICAL & ENGINEERING NEWS

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JULY 22, 1991

CHEMICAL SAFETY

Supercritical fluid nitrous oxide explosion

Although others have reported the use of nitrous oxide mixed with polar solvent modifiers such as ethanol or methanol for supercritical fluid extraction or chromatography, we have found that this can be quite hazardous. We experienced an explosion when we mixed supercritical nitrous oxide with 9% ethanol, 0.9% tetraethylorthosilicate, 0.07% triethylborate, and 0.07% triethylphosphite. This mixture was pressurized to 2100 psi at 40 °C in a stainless steel tee with an approximate volume of 1 mL. When the mixture spontaneously exploded, the tee ruptured and propelled the three stainless steel fittings into the surrounding equipment, embedding one fitting in a concrete wall, and doing a great deal of damage.

Others have often mixed much larger volumes of nitrous oxide (such as 500 mL) with ethanol or methanol in a syringe pump for use in supercritical fluid extraction or chromatography. This mixture could potentially be detonated by a shock wave or any catalyst in the pump or extraction apparatus or supercritical fluid chromatograph. Although ethanol acted as the fuel and nitrous oxide as the oxidizer in our explosion, extraction of other oxidizable organic samples with pure supercritical nitrous oxide could result in mixtures that can possibly be detonated.

Because large numbers of scientists may be exposed to this hazard, we urge that carbon dioxide or other less hazardous solvents be substituted.

Robert E. Sievers
Professor of Chemistry
Brian Hansen
Research Assistant
University of Colorado, Boulder

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 Teledyne Isco instrumentation, prudence and common sense must be used.

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.

CAUTION:
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 company's chemical/hygiene plan in the event of a spill.
In all cases, when using Teledyne Isco instrumentation, prudence and common sense must be used.

WARNING:
Team Lift. To reduce the risk of injury do not attempt to lift this instrument independently. It is highly recommenced that a team lift be used when lifting this instrument.

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.

AVIS:
Les liquides qui sont analysés 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.

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 Material 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: IscoService@teledyne.com

Technical Support

Phone: 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

Website: www.teledyneisco.com/who-we-are/contact-us

HL_f Series Syringe Pumps

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HL_f Series Syringe Pumps

Section 1 Introduction

1.1 Introduction

This manual is intended to instruct the user on pump installation.

1.2 Specifications

The technical specifications for the HL_f 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; hazardous locations and non-hazardous locations only.

⚠ WARNING

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

⚠ WARNING

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

⚠ 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 had been disconnected and the area is known to be non-hazardous

Table 1-1 100HL_f Technical Specifications	
POWER REQUIREMENTS ⚠ See section 1.5.	117 ± 12 Vac, 3.2 A maximum 234 ± 23 Vac, 1.6 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 60 ml/min (at any pressure from 0 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	3.86 nl
REFILL TIME	1.72 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 60 ml/min for any pressure up to 551.5 bar. For higher pressures see Figure 1-1.
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_f Technical Specifications	
POWER REQUIREMENTS ⚠ See section 1.5.	117 ± 12 Vac, 3.2 A maximum 234 ± 23 Vac, 1.6 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 / CONTROLLER 32.8 kg / 2.96 kg
FLOW RATE RANGE	1.0 µl/min to 107 ml/min at any pressure from 0 to 517.1 bar
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	2.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 107 ml/min for any pressure up to 276.1 bar. For higher pressures see Figure 1-2.
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

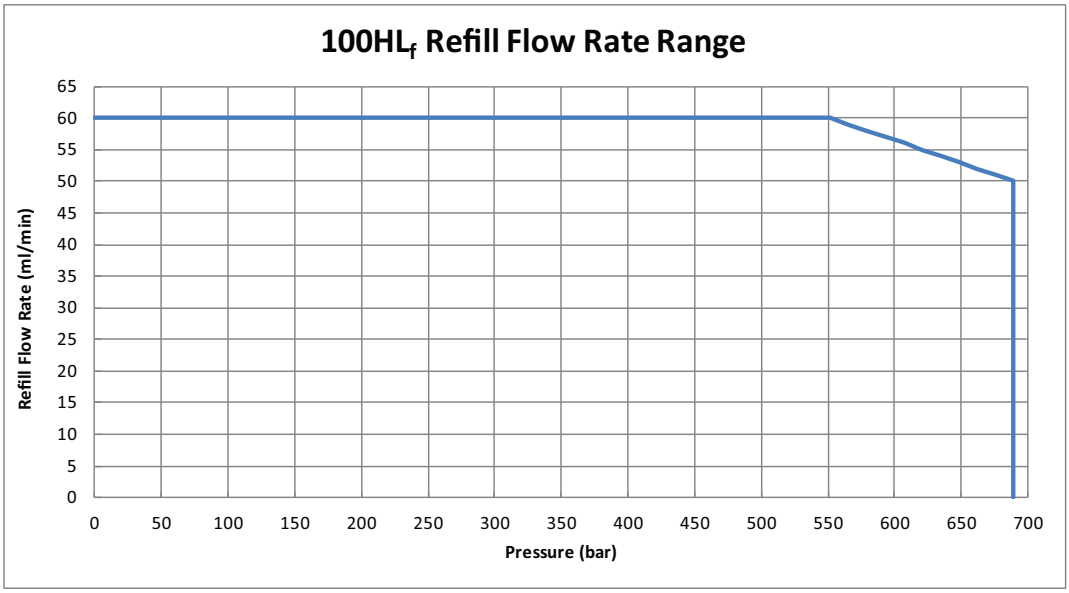
a. Using water at 137.9 bar and a temperature controlled environment at 30°C.
b. The analog output is an optional accessory.
c. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.
d. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-3 500HLf Technical Specifications	
POWER REQUIREMENTS ⚠ See Section 1.5	117 ± 12 Vac, 3.2 A maximum 234 ± 23 Vac, 1.6 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: 33.25 kg CONTROLLER: 2.96 kg
FLOW RATE RANGE	1.0 µl/min to 204 ml/min at any pressure from 0 to 258.6 bar
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	2.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 204 ml/min for any pressure up to 137.8 bar. For higher pressures see Figure 1-3.
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.

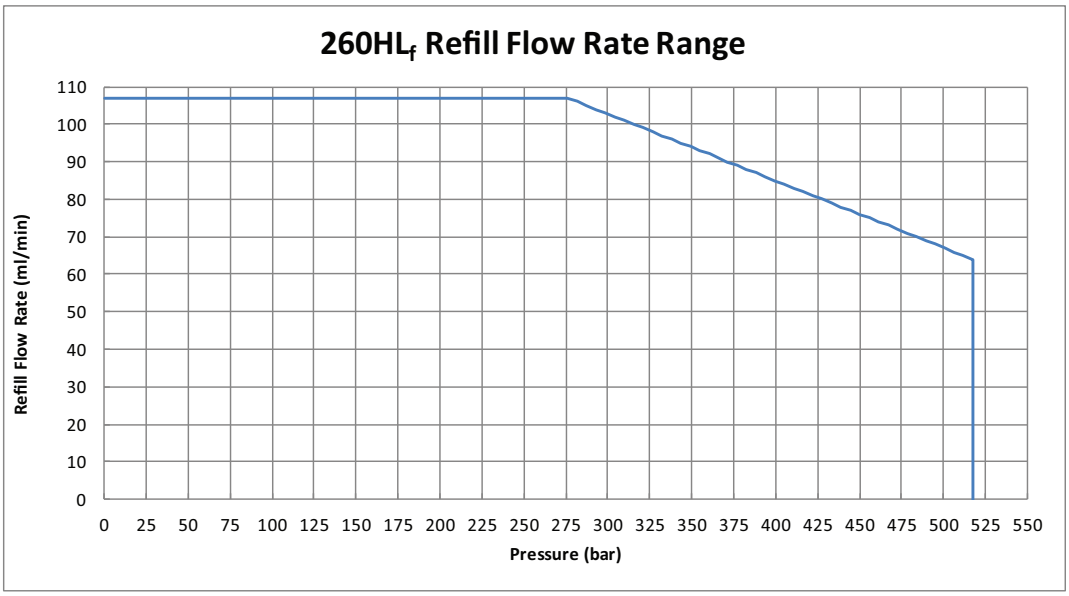
Table 1-4 1000HL_f Technical Specifications	
POWER REQUIREMENTS ⚠ See section 1.5, Installation Instructions	117 ± 12 Vac, 3.2 A maximum 234 ± 23 Vac, 1.6 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, 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[a]	PUMP 38.5 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	1.0 µl/min to 408 ml/min at any pressure from 0 to 137.9 bar
FLOW RATE ACCURACY[b]	± 0.5% (maximum 1.5 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	25.36 nl
REFILL TIME	2.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 408 ml/min for any pressure up to 68.9 bar. For higher pressures see Figure 1-4.
PRESSURE RANGE	0.6895 to 137.9 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[d]	± 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[e]	11.0 ± 0.7 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. A team lift is recommended when moving this instrument.
b. Using water at 137.9 bar and a temperature controlled environment at 30°C.
c. The analog output is an optional accessory.
d. 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.
e. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.



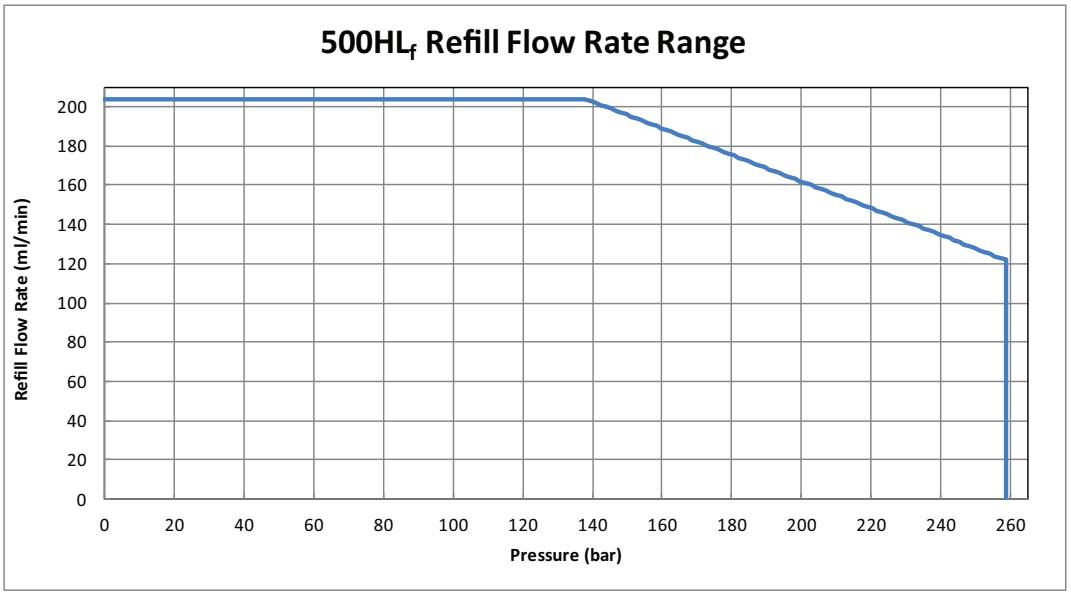
Refill Flow Rate (ml/min)	Maximum Pressure (bar)
0.0001 to 50	689.5
50 to 60	(100- Refill Flow Rate) x 13.789

Figure 1-1 100HLf refill flow rate range



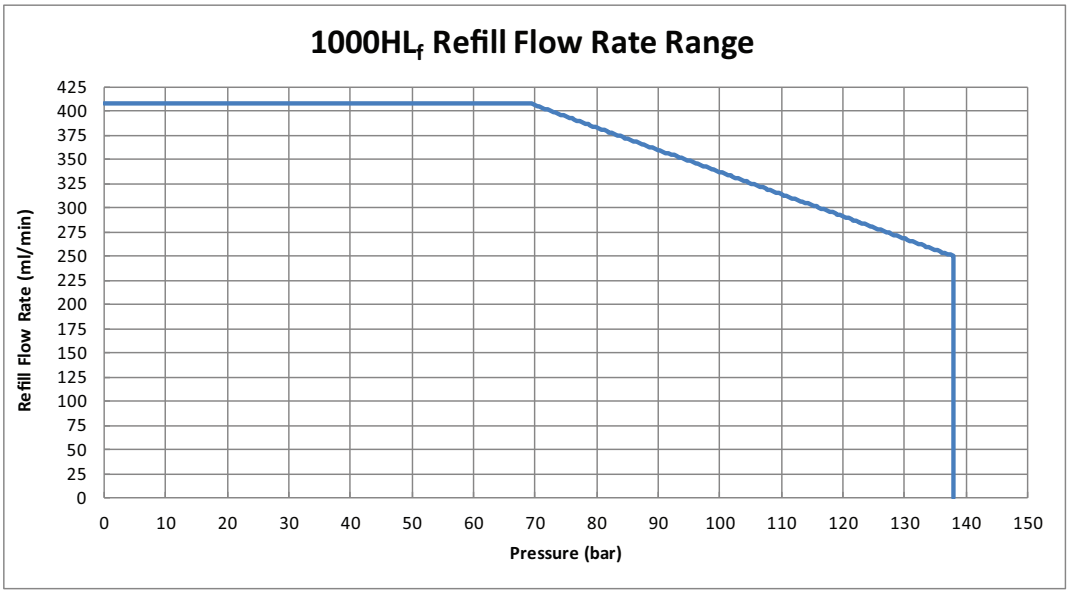
Refill Flow Rate (ml/min)	Maximum Pressure (bar)
0.001 to 64	517.1
64 to 107	(156.2- Refill Flow Rate) x 5.612

Figure 1-2 260HLf refill flow rate range



Refill Flow Rate (ml/min)	Maximum Pressure (bar)
0.001 to 122	258.6
122 to 204	(297.72- Refill Flow Rate) x 1.471

Figure 1-3 500HL$_f$ refill flow rate range



Refill Flow Rate (ml/min)	Maximum Pressure (bar)
0.001 to 250	137.9
250 to 408	(566- Refill Flow Rate) x 0.4364

Figure 1-4 1000HL$_f$ refill flow rate range

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 shortages, contact Teledyne ISCO immediately.

1.4 Controls and Indicators

The pump controller regulates all pumping functions. It is designed to sit on top of the pump base, but may be located elsewhere, according to safety and convenience. Programming and setup are performed using the keypad on the front panel. The controller front panel is shown in Figure 1-5 and described in Table 1-5. Table 1-6 explains the key functions.

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

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

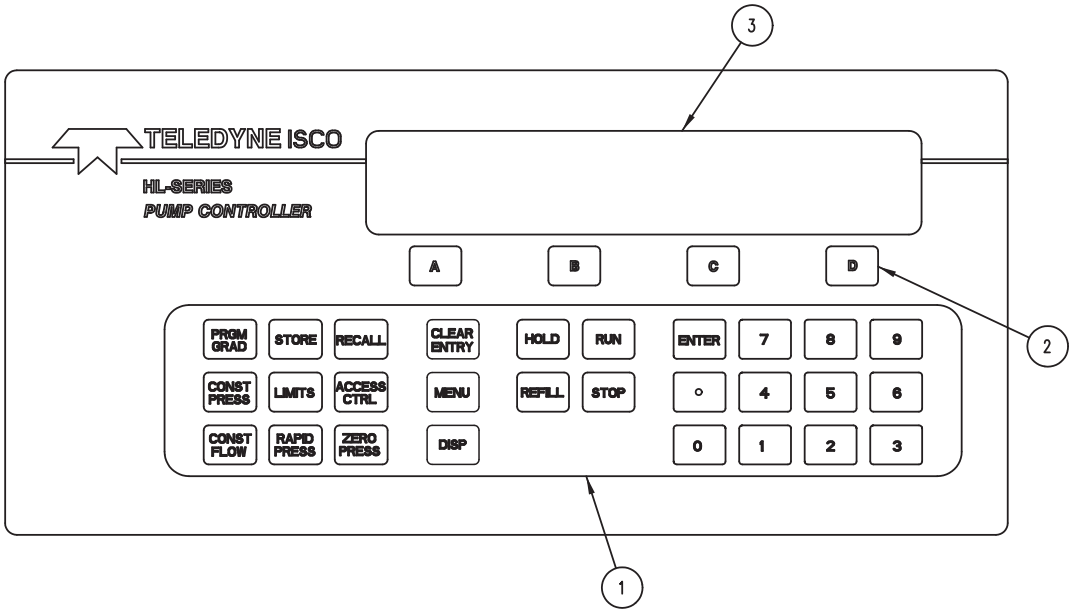


Figure 1-5 Pump controller key functions

Table 1-5 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, and D; used to select menu items displayed directly above them.
3	Liquid crystal display	40 Characters × 4 line.

Table 1-6 Pump Controller Key Functions

Key	Description
A, B, C, D	Softkeys; used to select displayed options.
PRGM GRAD	Puts the pump in gradient mode and accesses the softkey driven gradient programming.
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.
DISP	Activates dispense mode (refer to Section 3.10.3).
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.

☑ *Note*

A more in-depth explanation of the keypad is provided in Section 3 *Basic Programming and Operation*, under Section 3.8 *Front Panel Keys*.

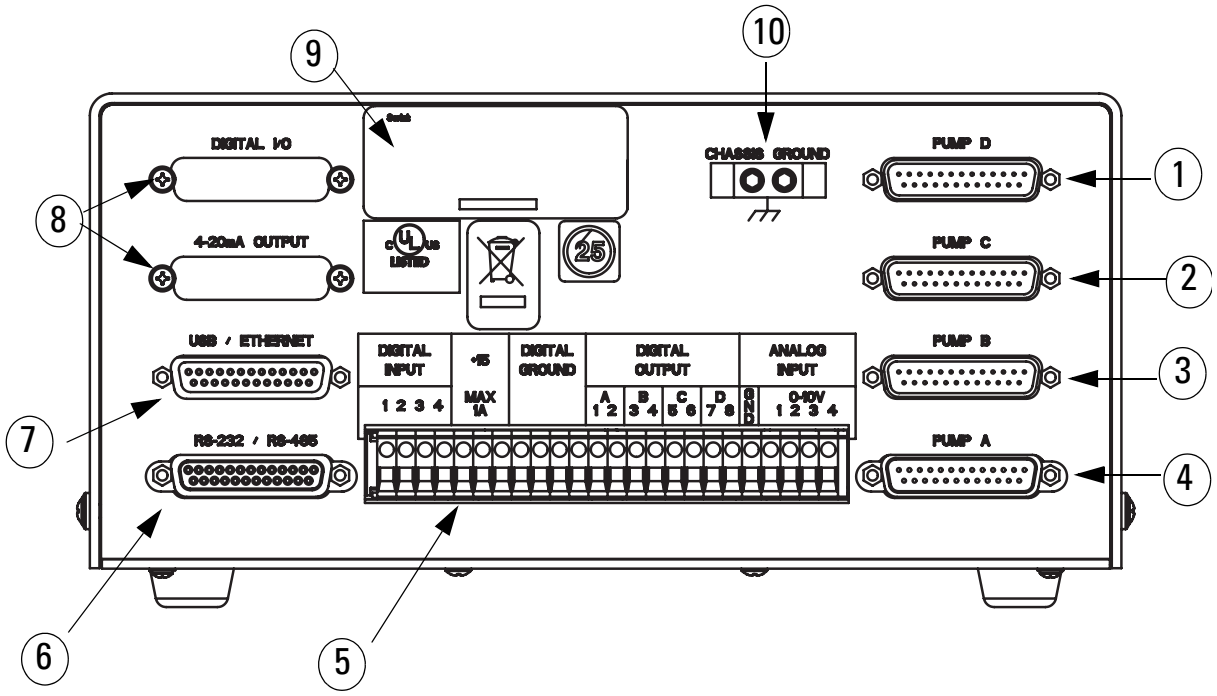


Figure 1-6 Pump controller rear panel connectors

⚠ 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 had 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	PUMP D	This connector is only used during multiple pump operation. The control cable from the rear panel of the **fourth** pump is attached to this connector.
2	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.
3	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.
4	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.**

5	ACCESSORY	These terminals allow connection of input and output signals (such as analog controls and external RUN/STOP).
6	RS-232/RS-485	This serial port connector may be used with an RS-232 or RS-485 cable to place the pump under remote control. Refer to Section 7 for RS-232 and Section 6 for RS-485 pin connections.
7	USB/ETHERNET	This connector may be used with a USB or Ethernet cable. Refer to Section 7 for USB pin connections and Section 6 for Ethernet pin connections.
8	4-20mA OUTPUT, DIGITAL I/O	Optional circuit provides 4-20mA current loop output and additional digital inputs and outputs.
9	SERIAL TAG	This tag indicates the serial number of the instrument.
10	CHASSIS GROUND	Ground point for high static or remote controller installations.

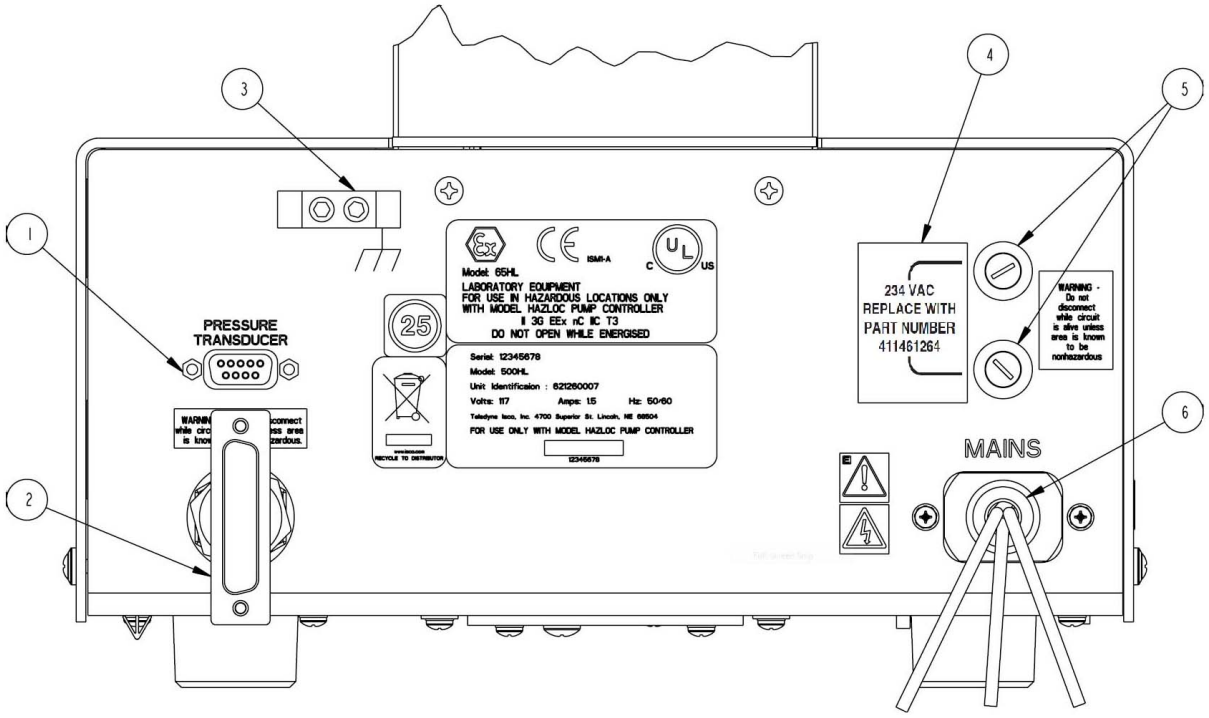


Figure 1-7 Pump rear panel connectors

⚠ 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 had 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	Fuse Label	234 VAC Replace with Part Number 41-1461-264 117 VAC Replace with Part Number 41-1461-271
5	Main Fuses	Call Teledyne ISCO for replacement.
6	AC Main 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 when circuits are energized. AC main 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.**

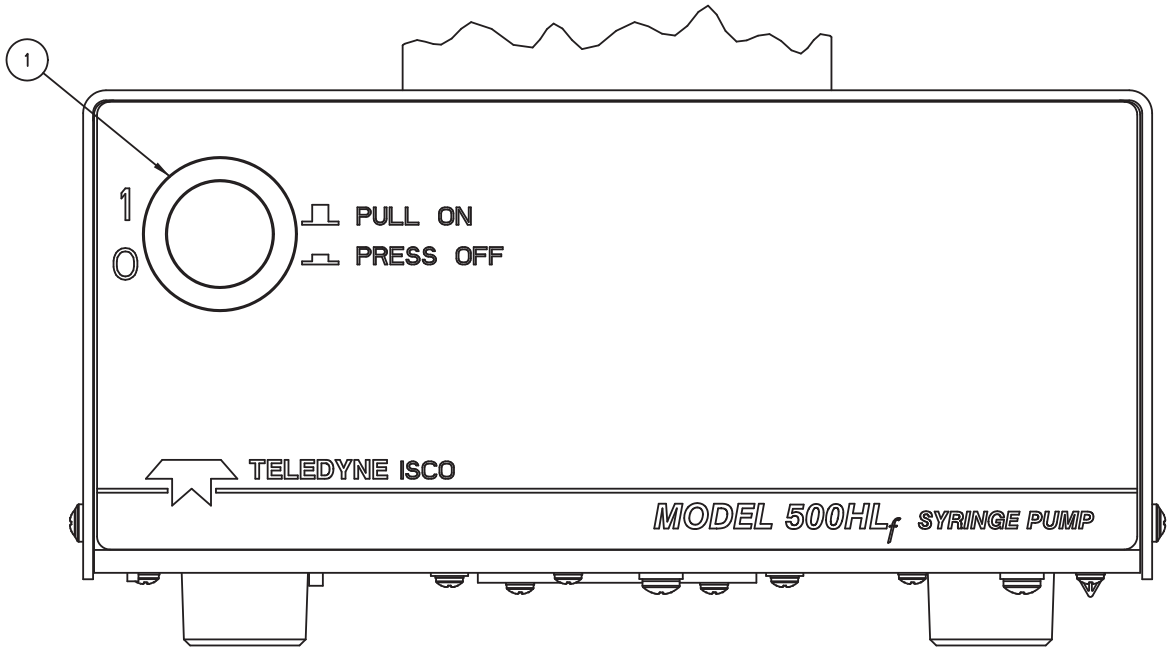


Figure 1-8 Pump front panel controls

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.

1.5 Electrical Connections

The pump controller may be placed on top of the pump. 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 four 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.

1.6 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.
5. 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.

> ☑ ***Note***
>
> Preliminary checkout the pump is performed without fluid in the pump.

System Checks

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.

```
PUMP CONTROLLER ISCO, INC. REV _______
<PUMP TYPE>
```

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 1 to select UNITS.
5. Press number 3 to select PSI for the pressure units.
6. Press number 5 to select ML/MIN for the flow units. The first line of the display will show the selected units.
7. Press softkey D, PREVIOUS, to return to the main menu.
8. Press softkey D, RETURN, to exit the main menu.
9. 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.
10. 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.

11. 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.
12. Once the setpoint and flow rate match, press the STOP key.
    a. If four pumps are connected to the controller, you will be prompted to press A to stop pump A, B to stop pump B, C to stop pump C, D to stop pump D, or STOP to stop all pumps.

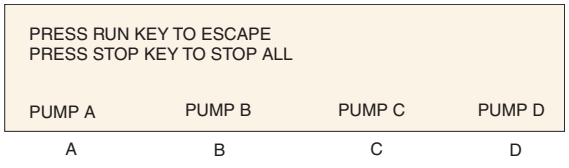


Figure 1-10 Four pump stop menu

    b. Otherwise, you will be prompted to press A to stop pump A, B to stop pump B, C to stop pump C, or D to stop all pumps.

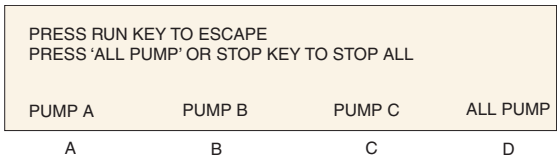


Figure 1-11 Three pump stop menu

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

HL_f Series Syringe Pumps

Section 2 Fluid System Connections & Accessories

2.1 Introduction

This section discusses general fluid system connections, and the installation of fluid connection accessories, temperature and pressure control accessories, and optional kits and attachments.

⚠ DANGER

RISK OF INJURY. THIS EQUIPMENT PRODUCES HAZARDOUS PRESSURES. USE APPROPRIATE TUBING AND CONNECTIONS AS INSTRUCTED.

☑ *Note*

When operating at flow rates at or below 500 µl/min, it is strongly suggested that an temperature control jacket be installed. See Sections .

2.2 Fluid System Connections

All HL_f Series pump models connect similarly, but with varying port sizes. Take care to follow the tips provided to ensure safety and proper operation.

2.2.1 Ports

There are two ports in the pump standard cylinder cap. Either port can serve as the inlet or outlet. You may plug one port and use a single port as both the inlet and outlet.

Standard port information

- $1000HL_f$ - ¼" NPT
- $100HL_f$, $260HL_f$- ⅛" Valco
- $500HL_f$ - ⅛" NPT

☑ *Note*

Custom caps are available with different port configurations and sizing. Contact the factory for details.

2.3 Fluids Certified for ISCO HL_f Pumps

⚠ WARNING

Pumping fluids that are not compatible with the HL_f 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_f 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.

2.3.1 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.
- Do not 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 leaks, 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, release all pressure inside the pump, then press ZERO PRESSURE on the front panel of the controller to readjust.

2.3.2 Tubing Requirements

The tubing must be cut squarely to prevent possible problems. Square ends are easier to insert through the ferrule, and will decrease dead volume.

Purchased cut tubing

Electrochemically machined steel tubing should be used throughout the plumbing system. Electrochemically machined tubing has flat, burr-free ends, and is free of cutting residues. This tubing is available pre-cut through many chromatographic supply distributors in assorted lengths.

Cutting the tubing

A 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.

⚠ CAUTION

Wear goggles to perform the following procedure.

Tools required: Fine jewelers file, goggles, and two pairs of pliers

1. Using the jewelers file, score the tubing around its entire circumference.
2. Secure the tubing with pliers on either side of the score line with approximately 1.5mm between each pair of pliers and the score line. Do not squeeze the tubing too tightly, as this will flatten or deform its exterior.
3. Bend the tubing back and forth to crack it at the score line.
4. It may be necessary to deburr the outer 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.

2.3.3 Accessory Packages

The accessory packages for all pumps contain fittings that allow you to attach tubing to the pump. Note that the tubing is not included.

Installation

1. Slide first the 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.

Table 2-1 HL_f Series Syringe Pump Accessory Packages

Pump Model	Part Number
1000HL_f	60-1269-010
500HL_f	60-1269-011
260HL_f	60-1269-012
100HL_f	60-1269-013

2.3.4 Draining Overflow

The drip tray outlet on the pump cylinder provides a means of draining fluid from seal leakage. Use the ¼" ID flexible tubing included with the accessory package to divert the leakage away from the pump.

To install the drain tube, push one end of the tubing over the end of the drip tray outlet, as shown in Figure 2-1.

☑ *Note*

The 1000HL_f has two drain tube outlets, one for the drip tray, and one for the splash pan, located at the bottom of the pump (see Figure 2-2). The 1000HL_f also includes a wash gland as a

standard feature (see the following section for details). The wash gland tubes can also be used as lines for draining away fluid.

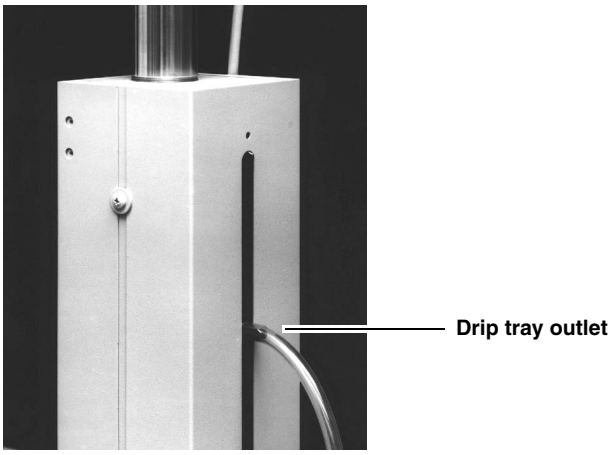


Figure 2-1 Drain tube installation

2.3.5 Cylinder Washing: Wash Gland

A thin film of liquid wets the inside of the cylinder each time the piston travels up the cylinder. The lowest flow rates are conducive to the most abrasive or corrosive pumping environments, as the deposited film remains on the inside of the cylinder wall for the longest time.

The Model 1000HL$_f$ syringe pump is equipped for cylinder washing, with two $^1/_8$" tubes on the back to feed and drain the wash gland, as shown in Figure 2-2 on the following page.

A small pump can be used to deliver the wash fluid through one of the two tubes to rinse the cylinder and seals. The second tube drains the wash fluid to waste. If the system is configured to recirculate the wash fluid, ensure that you change the wash fluid at regular intervals.

Select a wash fluid that will best flush the cylinder of any residue left by the pumped fluid, yet will not damage the seals.

⚠ CAUTION

The pressure in the wash gland and line should NEVER exceed the system pressure or the wash pressure limit as labeled on the pump. Units with a wash pressure limit label can be damaged if the pressure is exceeded.

☑ *Note*

If the primary pump seal fails, the pressure of the delivery fluid will be exerted on the secondary (wash gland) seal. During operation, the wash gland outlet should always be uncapped and routed for either recirculation or drainage.

Detailed information about pumping salt solutions and brines is available in technical bulletin TB04 Pumping Salt Solutions and Brines.

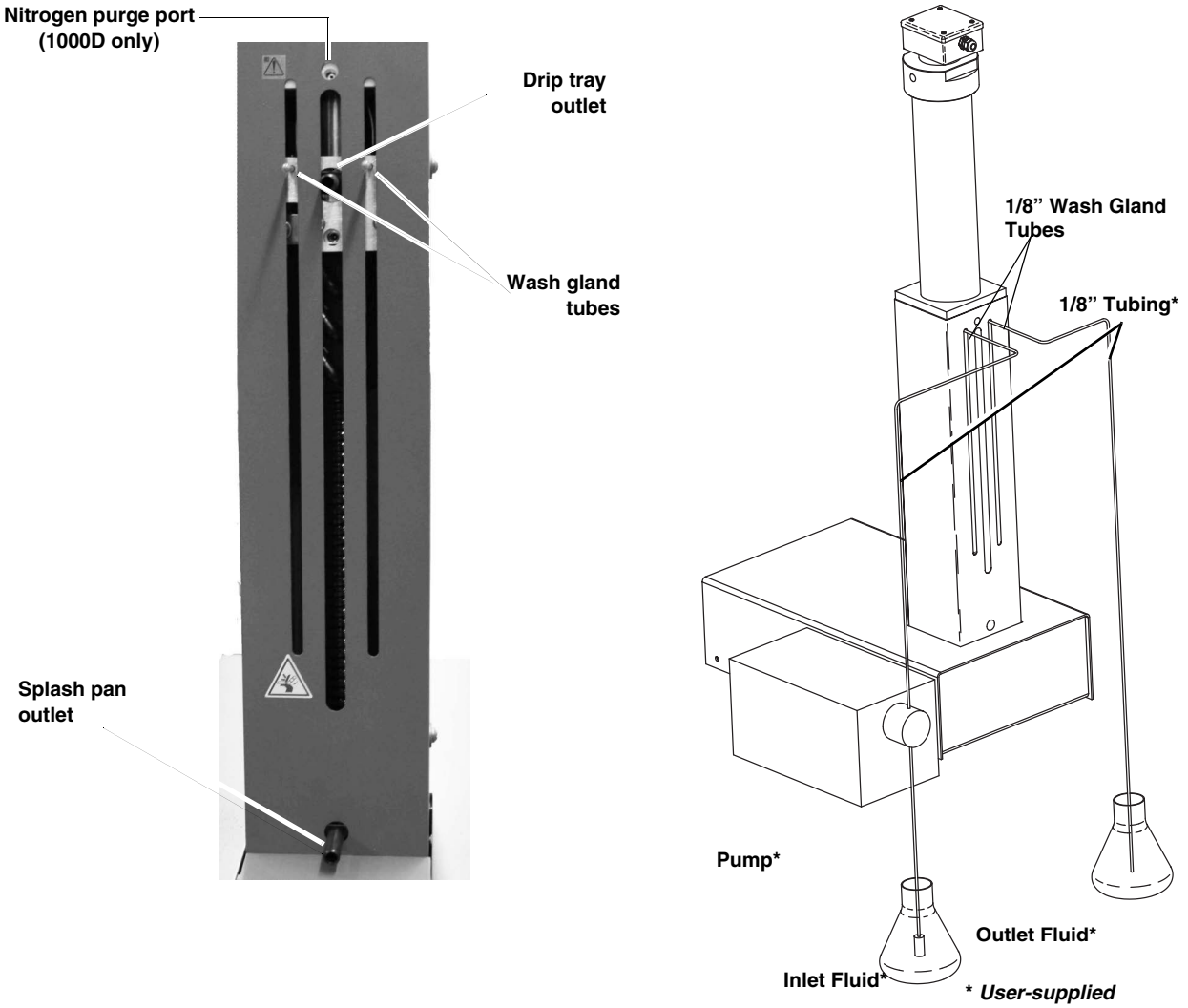


Figure 2-2 Drain tube installation and wash gland connection

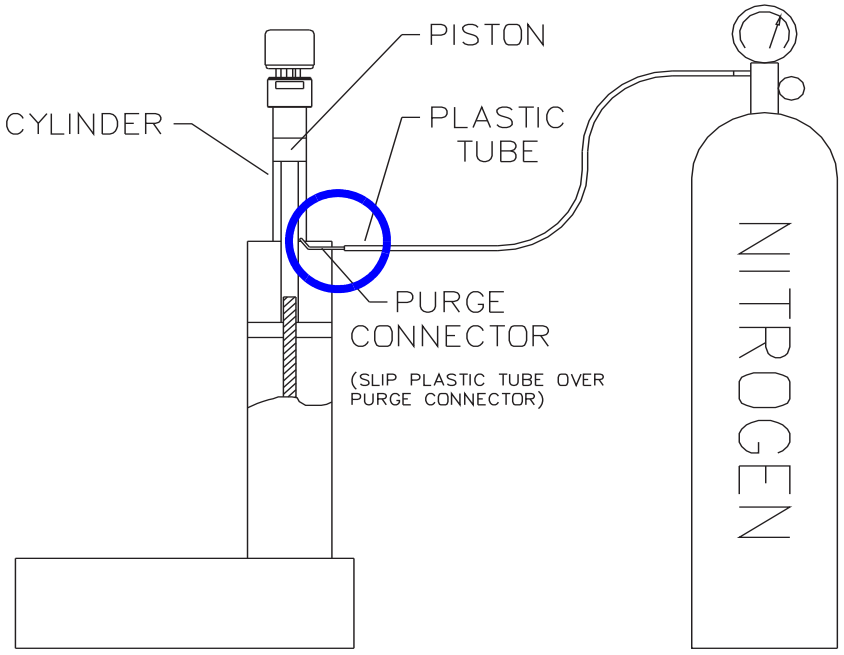
> **Note**
>
> Wash gland options are available for the 500HL$_f$ syringe pump, with $^1/_{16}$" wash tubes. Contact Teledyne ISCO for more information.

2.3.6 Cylinder Washing: Nitrogen Purge

All pumps that do **not** have a wash gland are equipped with a purge connector tube near the top of the pump body. The purge connector enables the pump cylinder beneath the piston to be purged with nitrogen, which can increase useful cylinder life by flushing residue from the system. Figure 2-3 shows a typical connection to the purge tube on the back of the pump.

To purge with nitrogen

1. Attach gas supply by slipping the plastic tube over the purge connector, as shown below.
2. Regulate the nitrogen supply to slightly above atmospheric pressure.



Close-up view of nitrogen purge tube (This view applies to pumps other than the 1000D)

Figure 2-3 Purge connector installation

⚠ WARNING

Liquids expelled by compressed gasses may cause injury. Wear eye protection. Certain liquids also may require other personal protective equipment. Refer to the applicable Material Safety Data Sheet (MSDS) for more information.

2.4 Fluid Connection Accessories

The optional accessories discussed in this section are used to make fluid connections from the pump(s) to another apparatus.

When making fluid connections that use ferrules, be sure to use the ferrules provided in the kit. Push the tubing completely into the connector and finger-tighten. Then tighten with a wrench to clamp the ferrules onto the tubing.

2.4.1 Manual Refill Kit

The optional manual refill kit provides a high pressure, two-way valve that connects to the pump inlet to a fluid reservoir. The kit contains all tubing and hardware necessary for valve installation. Kit components and connections are shown in Figure 2-4.

Kit installation

1. To attach the two-way valve to the pump housing, use the valve spacer block and screws provided.
   a. For the 500HL_f pump, screw the male adapter into the inlet port of the pump.
2. Connect the pre-bent stainless steel tubing from the valve to the pump inlet. Use the nut and ferrule to connect the tubing at the inlet and the valve fittings to connect the tubing at the valve.
3. Connect the PTFE refill tubing (with the filter) to the port of the two-way valve, using the nuts and ferrules supplied.

☑ *Note*

When connecting to pressurized sources in super critical fluid applications, use the stainless steel tubing **without** a filter. An in-line filter is contained in the CO_2 connection package (refer to Section 2.4.3).

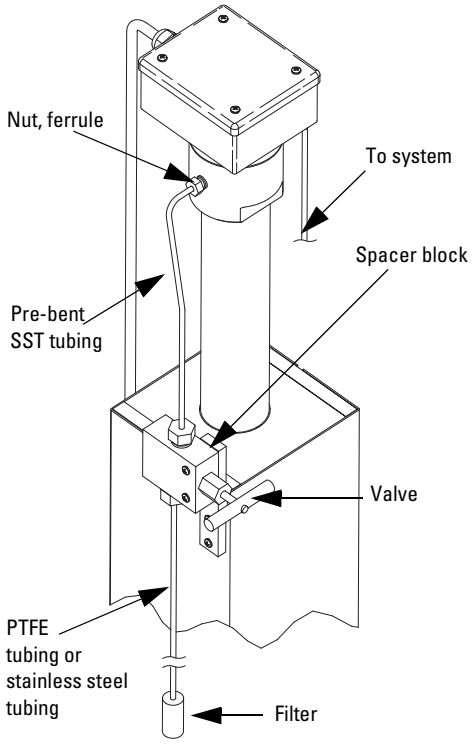


Figure 2-4 Refill kit installation

Table 2-2 Manual Refill Kits

Pump Model	Part Number
1000HL_f	68-1247-117
500HL_f	68-1247-083
100HL_f, 260HL_f	68-1247-077

⚠ DANGER

RISK OF INJURY. THIS EQUIPMENT PRODUCES HAZARDOUS PRESSURES. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS AS NOTED IN THE MANUAL.

2.4.2 Manual Outlet Valve Kit

The optional manual outlet valve kit provides manual control of the pump outlet port by connecting a shutoff valve between the pump and the rest of the system.

Kit installation

1. Attach the two-way valve using the spacer block and pan-head screws.

a. For the 500HL_f pump, screw the male adapter into the pump outlet.

2. Connect the pre-bent length of stainless steel tubing to the outlet port on the pump using the nut and ferrule. Connect the other end to the top port on the valve using the valve fitting.

☑ Note

For the 500HL_f, this piece of tubing should be cut to the proper length for connection to your system. Due to the wide variety of applications for this model, fittings to connect the tubing to your system are not provided in the kit.

☑ Note

When nuts are torqued to the cylinder cap ports, the pressure reading may be affected. If the pressure no longer reads zero, release the pressure in the cylinder and press ZERO PRESS.

3. Use the valve fittings to attach stainless steel tubing to the top port of the two-way valve.
   a. For models 100HL_f and 260HL_f, connect the reducing union to the other end of this tubing.
4. Connect the stainless steel tubing between the valve's bottom port and your apparatus. Cut to the desired length.

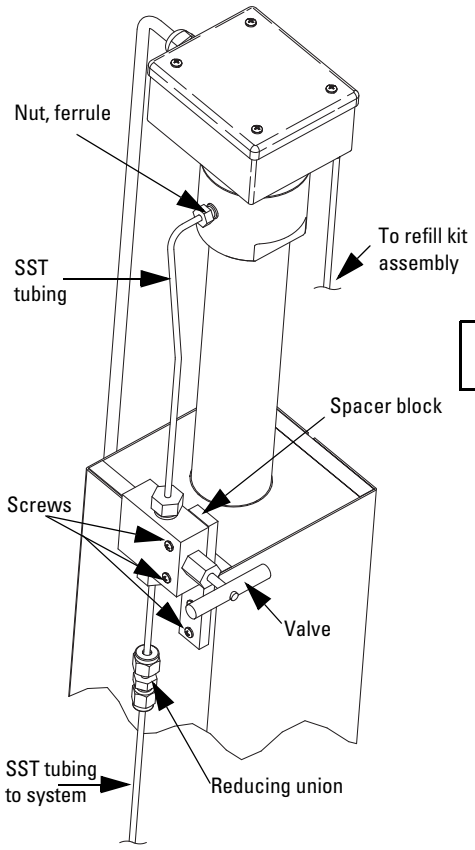


Figure 2-5 Outlet valve package connection

Table 2-3 Manual Outlet Valve Kits

Pump Model	Part Number
1000HL_f	68-1247-118
500HL_f	68-1247-082
100HL_f, 260HL_f	68-1247-078

⚠ DANGER

RISK OF INJURY. THIS EQUIPMENT PRODUCES HAZARDOUS PRESSURES. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS AS NOTED IN THE MANUAL.

2.4.3 In-Line Filter Package The optional in-line filter package should be used when it is important to filter flow exiting the pump. This package contains a 0.5 µm filter and 1⁄16" tubing.

Table 2-4 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

Installation

1. Attach the reducing adapter from the 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.

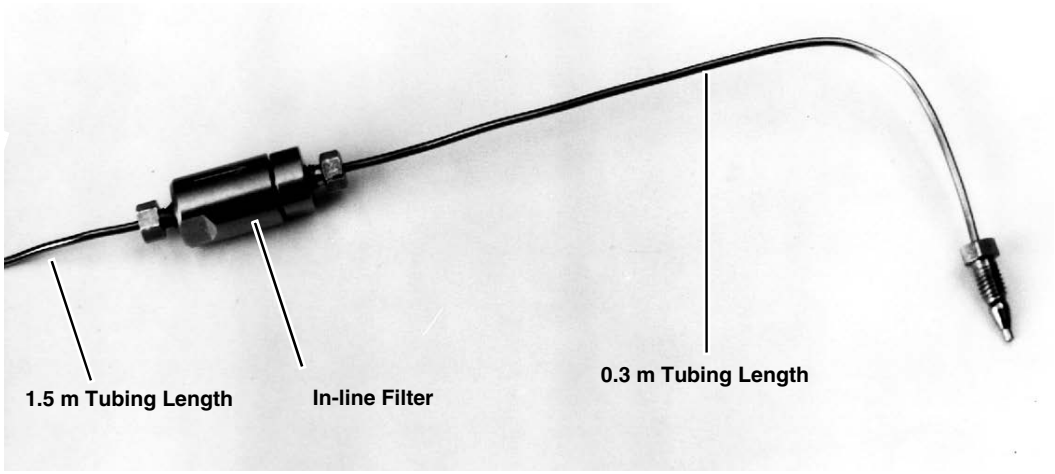


Figure 2-6 In-line filter package

2.5 Temperature and Pressure Controls

Some applications, such as those with very low flows, may require additional measures to maintain steady rates.

2.5.1 Cylinder Insulating Cover

The optional insulating cover can reduce flow noise due to temperature fluctuations and improve pump performance at flow rates under 500 µl/min.

> ☑ ***Note***
>
> The insulating cover is not available for Model 1000HL$_f$.

Part numbers:

- Insulating cover for 100HL$_f$, and 260HL$_f$
  60-1267-003
- Insulating cover for 500HL$_f$
  60-1267-004

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

Figure 2-7 Cylinder insulation cover

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

Installation

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.

2.5.2 Temperature Control Jacket

The optional cylinder temperature jacket assists in maintaining cylinder temperatures (–30 to 100°C) by circulating liquids, such as water or water/ethylene glycol solution, through the ¼" upper and lower hose connectors.

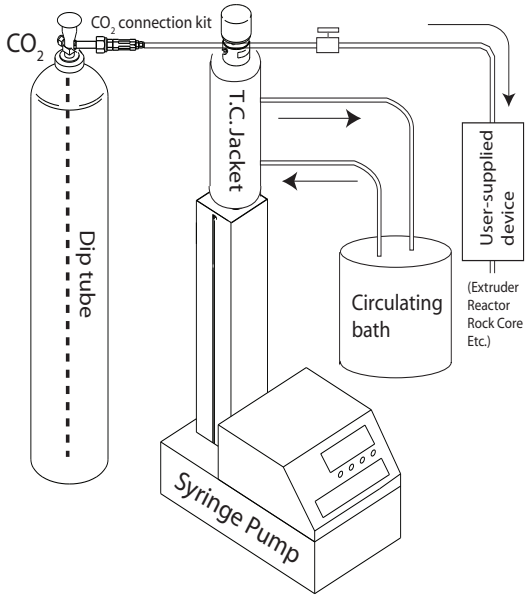


Figure 2-8 System with temperature control jacket installed

The jacket is very useful for SFC applications where cylinder cooling facilitates filling with fluids such as liquid CO_2. The jacket can also 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 500 µl/min), where temperature fluctuation can cause flow variations.

> ☑ ***Note***
>
> Temperature control jackets must be pre-installed at the factory.

2.5.3 Fluid Temperature and Volume

The fluid, circulation, and heating/cooling reservoir connected to the temperature control jacket are user-supplied. Water baths generally come with a built-in pump, and are available in a wide variety of temperature ranges and fluid capacities from many lab equipment suppliers, such as Cole Parmer or Thomas Scientific.

The model 1162 120V refrigerated circulating bath from Sensotec is an example of a bath for applications such as super critical CO_2.

Temperature Ranges

The jacket itself is rated from –30 to 100 °C. However, bath temperatures are also determined by the type of seals used in the syringe pump.

- The standard pump seals are rated up to 70 °C.
- While the High Temperature pump seals are rated up to 200 °C, due to the jacket seal rating, **do not exceed 100 °C**.
- For pumps using virgin PTFE seals, contact the factory for assistance.

Volume

Fluid bath volume is determined by cylinder volume. To maximize temperature stability, a minimum of twice the cylinder volume should be used. Refer to Table 2-5 for recommended fluid volumes.

Table 2-5 Recommended Circulating Bath Volumes

Pump Model	Min. Volume (ml)
$100HL_f$	205.86
$260HL_f$	532.10
$500HL_f$	1014.76
$1000HL_f$	2030.00

2.5.4 Back Pressure Regulation

The back pressure regulator option from Teledyne ISCO reduces flow noise and improves pump performance at pressures less than 3.5 bar. Two back pressure regulators are available:

- 7 bar, part#209-9012-22
- 5 bar, part#209-9012-21

Fittings to connect the tubing to the regulators are supplied.

⚠ DANGER

RISK OF INJURY. THIS EQUIPMENT PRODUCES HAZARDOUS PRESSURES. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS AS NOTED IN THE MANUAL.

Installation

1. Note the arrow on the regulator indicating the fluid direction.
2. Connect your tubing between the pump outlet and the regulator using the supplied fittings.

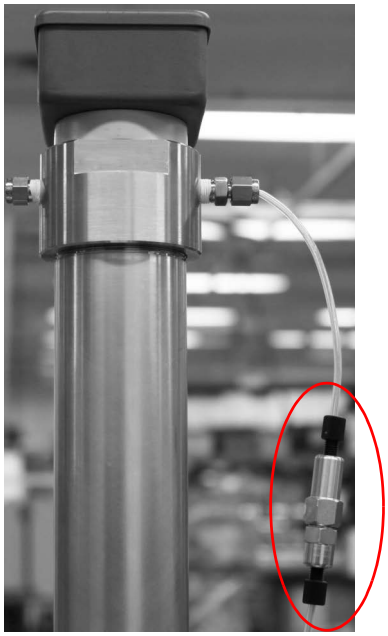


Figure 2-9 Back pressure regulator

HL_f Series Syringe Pumps

Section 3 Basic Programming and Operation

3.1 Introduction

This section will familiarize you with the HL_f 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_f 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, DISP, and REFILL all have such dedicated keys.

⚠ WARNING

UL (Underwriter Laboratories) has certified the HL_f 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.

If you make an incorrect entry, press CLEAR ENTRY to delete your last keystroke. If you have entered a programming mode but do not wish to make any changes, press ENTER to keep the current setting, or press softkey D to return to the previous screen.

3.2.1 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 3.4.1.

The pump also allows user programmed refill, as well as pumping rates, refer to Section 3.4.3.

The system protection limits may also be set by the user, refer to Section 3.8.7.

3.2.2 Programming Screens

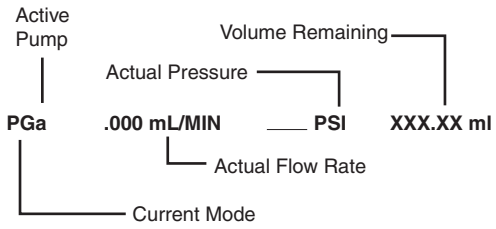
The programming screens are divided into separate menus. These menus are accessed when different features are being programmed. For complete information about programming menus, refer to Sections 3.3 through 3.7.

3.2.3 Run Screens

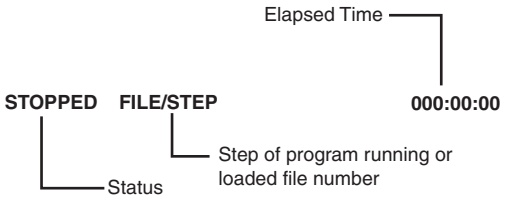
The run screen appears once a program has been loaded and the pump is running.

The run screen, which is determined by your program selections, displays current information about pump operation. The following sections explain the display line by line.

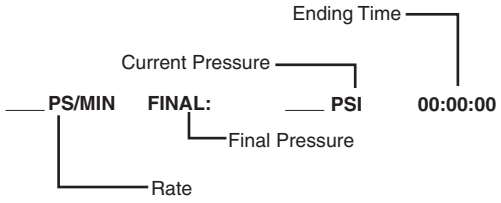
Line One – No matter what mode you are in, the first line of the run screen is always the same.



Line Two – The second line varies slightly depending on the operating mode. A file or step will only be displayed when operating in the gradient 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.

3.2.4 Selecting Operating Parameters

There are four ways to program the system from a menu screen.

Menu Selection – The number keys are used to select from listed menu items.

Softkey Selection – The softkey programming options appear on the fourth line of the screen. To either toggle or select an option, press the softkey, A-D, directly below that option.

Keypad Selection – The programming keys are located on the left side of the 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, a message will blink, prompting you to enter an appropriate value.

3.3 Main Menus

There are four main menu screens. Access Menu 1 by pressing MENU. To move forward and back between Menus 1, 2, 3 and 4, or to return to the run screen, use softkeys A (MORE) and D (PREVIOUS/RETURN).

Use the number keys to select a menu option. Selecting a menu option displays the programming parameters for that option in menu form.

> ☑ ***Note***
>
> To exit a menu when multiple pumps are connected, press the STORE, RECALL, CLEAR ENTRY OR MENU key.

3.4 Menu One

Menu 1 provides programming options for units of measure, pump selection, refill settings, power failure response, system reset, and display contrast adjustment.

To save all settings and return to the main menu, press RETURN (D).

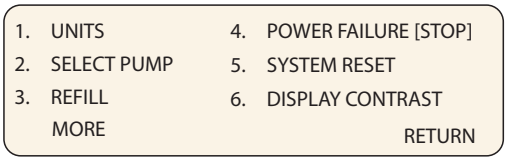


Figure 3-1 Menu 1 program selections

3.4.1 Flow and/or Pressure Units of Measure

Displayed units are user-selectable by selecting menu 1 item 1.

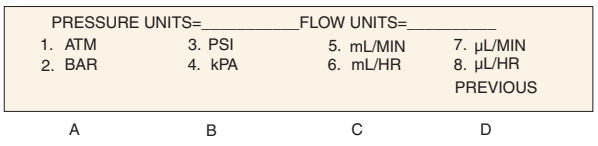


Figure 3-2 Units menu

Use numbers 1-4 to select the pressure units (ATM, BAR, PSI, kPa). The units selected will be displayed on the first line after PRESSURE UNITS=.

Use numbers 5-8 (mL/MIN, mL/HR, µL/MIN, µL/HR) to set the flow rate units. The selected units will be displayed on the first line after FLOW UNITS=.

3.4.2 Pump Selection (if multiple pumps)

If multiple pumps are connected to a single controller, the SELECT PUMP option selects the pump (A, B, C, or D) whose current state and settings appear on the display.

The letter of the current pump will appear in lower-case in the upper left corner of the run screen.

> **☑ Note**
> When multiple pumps are connected, the UNITS selected for one pump will apply to all of the pumps.

3.4.3 Refill

The refill option allows you to set the refill rate or set the pump to automatically refill when a certain volume is reached.

Press MENU > REFILL (3). The auto refill menu will appear.

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

To set auto refill volume

Press 1 to set the volume for pump A.

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 ENTER.

To set refill rate

1. Press 3 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 with the number keys; press ENTER.
4. To save and exit the refill menu, press D, PREVIOUS.

Disable / Enable auto refill

The first line will display “OFF” or “ON”, indicating whether or not this feature is enabled for pump A (or the currently selected pump). Press 4 to toggle this feature off or on for each pump.

> **☑ Note**
> Auto refill can be set independently for each pump.

If AUTO REFILL is ON, 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.

Unless otherwise specified, the pump will refill to full cylinder capacity. To specify a smaller refill volume, press 2 and enter the desired volume. Press 5 to toggle this feature off or on for each pump.

☑ Note

The system can also be programmed to refill a pump based on an external analog input voltage, with a range of 0 to 11.5 volts. Information about this feature is provided in Section 3.12.3.

3.4.4 Power Failure [STOP]

This feature allows you to set the activity of the pump in the event of a power failure. Press 4 to toggle this feature between [STOP] (to remain stopped after power is restored) or [CONT] (to automatically resume after power is restored).

☑ Note

In a multiple-pump system, this action is applied to all connected pumps.

3.4.5 System Reset (Restore Default Settings)

To restore default program settings, press 5. To continue with the reset, press CONTINUE (A); to cancel the reset, press DO_NOT (D).

⚠ CAUTION

Resetting the system erases all programs and user settings.

This is a basic reset. For information about performing a "hard" reset, refer to Section 8.3.2.

3.4.6 Display Contrast

From the menu, you can adjust the screen brightness for your light conditions and viewing angle.

Use softkeys B, DOWN, or C, UP to reduce or increase the brightness.

3.5 Menu Two

Menu 2 provides programming options for serial communication, pump status, external control, multiple pump operation, volume reset, and valve control.

To save all settings and return to the main menu, press PREVIOUS/RETURN (D).

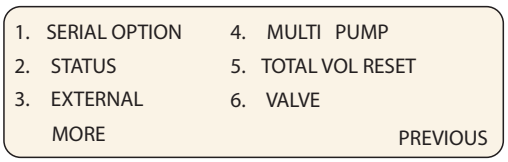


Figure 3-3 Menu 2 program selections

3.5.1 Serial Option

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

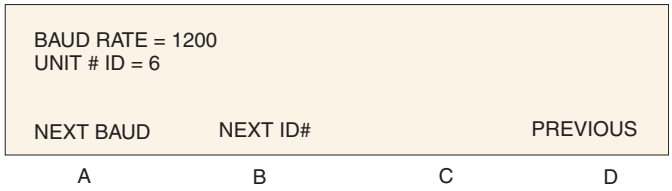


Figure 3-4 Serial option menu

Use softkey A, NEXT BAUD, to scroll through the available baud rates. These are: 300, 1200, 2400, 4800, 9600, 19.2K, 38.4K, 57.6K, and 115.2K.

Use 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 Teledyne ISCO LabView™ software.

For a complete discussion of serial control, refer to Section 7 in this manual.

3.5.2 Pump Status

This option displays the controller software revision, and model of connected pump(s).

The first line displays the revision of the software.

Lines 2, 3, and 4 display the type of pump connected to the A, B, C, and D pump connectors, respectively.

This screen is also momentarily displayed automatically each time the pump controller is switched on.

3.5.3 External Control

The pump pressure or flow rate operation can be controlled externally with an analog voltage. Complete instructions for this feature are provided in Sections 3.12 through 3.12.5.

3.5.4 Multiple Pumps

One controller can control up to four pumps at once, either together or independent of each other.

Complete information about using the MULTI PUMP feature is provided in Section 3.9 and Section 5.6.

3.5.5 Total Volume Reset

This option resets the total volume display of multi-pump pair AB or multi-pump pair CD to zero when operating in continuous flow or modifier mode.

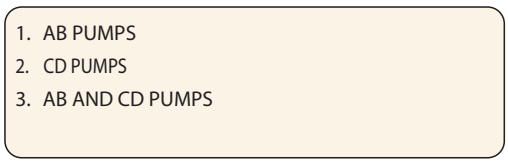


Figure 3-5 Total volume reset

3.5.6 Valve

This feature identifies the type of valves (passive or active (air), being used for the flow operation. Valves are set to "active" by default. If "active value" is selected, the controller will match the pressure more closely before switching delivery pumps.

The number for the selected valve type will be blinking.

Press 1 or 2 to select the correct valve type.

3.6 Menu Three

Menu 3 provides programming options for poor fills, diagnostics, pressure calibration, alternative pressure inputs, pressure control setting, and pressure setpoint tolerance.

To save all settings and return to the main menu, press PREVIOUS/RETURN (D).

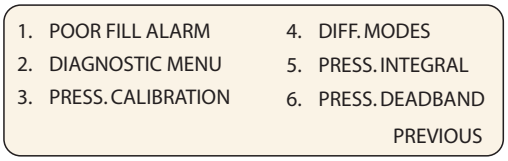


Figure 3-6 Menu 3 program selections

3.6.1 Poor Fill Alarm

In 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 issues an alarm and stops the pump.

3.6.2 Diagnostic Menu

This selection displays an additional menu containing testing options for the system. Refer to Section 9.5 for a complete explanation of how to use the diagnostic menu.

3.6.3 Pressure Calibration

This is a stored psi value to ensure optimal operation of the pressure transducer. On most pumps, this value, known as the "midpoint adjustment," can be found on a tag on the transducer cable (shown below).

Standard calibration for the transducer is a two-point adjustment, at zero and maximum pressure. The midpoint adjustment number is the difference between the pressure at half maximum, as read by a pressure gauge with a precision of 0.25% accuracy, and the syringe pump transducer output.

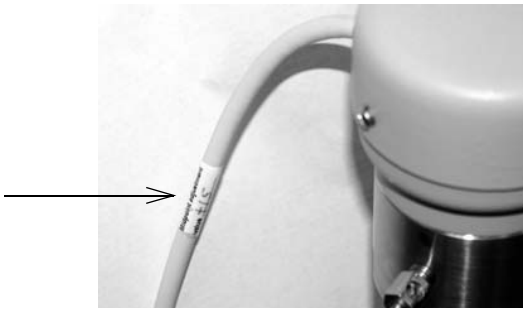


Figure 3-7 Location of transducer midpoint value

Press CALA, CALB, CALC, or CALD to select the correct pump, enter the calibration number, and press ENTER.

> ☑ ***Note***
>
> This calibration feature is not applicable to HL_f model pumps. The midpoint adjustment value is individual to each pump, and is stored within the controller software. Therefore, this value must be re-entered if the controller or pump is switched, controller is reset, or if a pump is plugged into a different port on the controller.

3.6.4 Diff. Modes

This feature allows the use of other analog inputs for pressure input to the pump. The standard pressure transducer **MUST** be connected to pump in order for this feature to work.

Press 1, OFF, to turn off this feature.
Press 2, 0 to 50 ANLG1, to use a 5 volt 50 psi transducer on ANALOG INPUT 1 of the ACCESSORY connector.
Press 3, Custom ANLG1, to use 5 volt custom pressure transducer on ANALOG INPUT 1 of the ACCESSORY connector.
Press 4, 500 ANLG2, to use a 5 volt 500 psi pressure transducer on ANALOG INPUT 2 of the ACCESSORY connector.
Press 5, 5000 ANLG3, to use a 5 volt 5000 psi transducer on ANALOG INPUT 3 of the ACCESSORY connector.

3.6.5 Press. Integral

If the pressure control appears to be unstable or incorrect, toggle this feature on by pressing 1, 2, 3, or 4 for the correct pump; this activates a proportional integral derivative (PID) controller, which minimizes errors in the pressure control process.

This feature is on by default.

3.6.6 Pressure Deadband

This feature dampens the corrective response to slight variations in pressure to reduce fluctuation. If the pressure reading at the programmed setpoint appears to be unstable, toggle this feature on by pressing 1, 2, 3, or 4 for the correct pump.

This feature is on by default.

3.7 Menu Four

3.7.1 Modbus Options

The Modbus RTU and Modbus TCP communications protocol is supported. Complete information about using Modbus RTU and Modbus TCP communication is provided in Section 6 “Modbus Configuration”.

3.8 Front Panel Keys

In addition to the menu options, certain functions and modes are selectable from the front panel keyboard.

3.8.1 CONST PRESS and CONST FLOW

These keys place the system in constant pressure mode or constant flow mode, respectively. Information for these operating modes can be found in Section 3.10.

3.8.2 PRGM GRAD

This key is used to place the pump system in gradient mode. For complete information about gradient programming, refer to Section 4 *Gradient Pumping for Pressure, Flow, and Concentration Modes*.

3.8.3 HOLD

The HOLD key is used while a gradient is running. When HOLD is pressed, the program clock freezes and current gradient parameters are maintained.

To continue the gradient, press HOLD or RUN.

3.8.4 RECALL

The RECALL key can only be used when the pump(s) are stopped or when in HOLD mode. The RECALL key is used to recall a previously programmed gradient. When you select this option, the controller automatically loads the gradient and switches the pump to program gradient mode.

1. Press RECALL and use the number keys to enter the number name of the gradient you wish to recall. Press ENTER.
2. If you enter a number of a gradient that does not exist, the controller briefly displays the message “FILE NUMBER DOES NOT EXIST.” It then assumes you will be creating a new gradient under that number and displays the program gradient run screen.

3.8.5 STORE

The STORE key is operational in the programmed gradient mode. It is used to save the program gradient parameters and exit the programming (parameter entry) mode.

3.8.6 REFILL

The REFILL key manually places the pump in refill mode.

3.8.7 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 corre-

spond 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 currently selected pump.

- The maximum and minium limits you set cannot exceed the pump specifications.

To set the limits

1. Press LIMITS. To display the Limits menu, enter the number of the limit you wish to program. One of five limit setpoint menus will appear: MAX PRESS, MIN PRESS, MAX FLOW, MIN FLOW, or FLOW LIMIT. The MAX PRESS limit setpoint menu is shown in Figure 3-9.

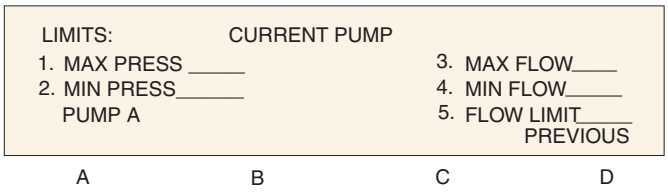


Figure 3-8 Limits menu

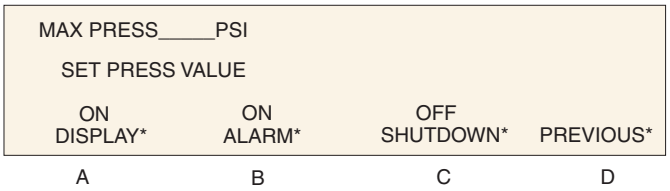


Figure 3-9 Limits setpoint (Max Press) menu

☑ 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 ENTER 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 menu, press the softkey D, PREVIOUS. If four pumps are connected press STORE, RECALL, or CLEAR ENTRY to exit the limits menu.

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, which toggle the feature on and off.

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

Display

When a limit has been exceeded, this feature causes the display to automatically flash an OVER or UNDER LIMIT message. To turn off this function, press softkey A once to toggle to:

OFF
DISPLAY

Alarm

When a limit has been exceeded, this feature causes the pump to automatically beep a warning. To turn off this function, press softkey B once to toggle to:

OFF
ALARM

Shutdown

When a limit has been exceeded, this feature causes the pump to shut down. To turn off this function, press softkey C once to toggle to:

ON
SHUTDOWN

Flow rate limit for pressure control

When the pump is controlling pressure (CONSTANT PRESSURE MODE), the flow rate is not user-controlled, and may range up to the maximum flow of the pump. 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 save your changes and return to the main menu, press softkey D, PREVIOUS.

3.8.8 RAPID PRESS

This option is available when operating in the constant flow mode and in the two-pump concentration gradient 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 CONST FLOW to put the pump in constant flow mode, or enter a two-pump concentration gradient.
2. Press RAPID PRESS.
3. The controller will display maximum flow rate and target pressure setting. If these values are correct, press 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 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 B and enter the desired flow rate limit.
6. Press D to continue rapid pressurization.

3.8.9 DISP

The DISP key activates Dispense Mode, for applications such as reactant feed and batch delivery, where a specified volume is pumped. Refer to Section 3.10.3 for programming steps.

3.8.10 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.

1. Press ACC CTRL.
2. From the accessory control menu, use the number keys 1-8 (1-A INLET, 2-A OUTLET, 3-B INLET, 4-B OUTLET, 5-C INLET, 6-C OUTLET, 7- D INLET, 8- D OUTLET) to toggle the desired valve open or closed. (Numbers 1-8 represent digital output terminals 1-8, respectively).
3. To exit, press PREVIOUS (D).

3.8.11 ZERO PRESS

The ZERO PRESSURE key will correct pressure sensor drift. Before pressing ZERO PRESS, the pump should have port fittings installed, and be depressurized.

1. Press ZERO PRESS. The display will show the current pressure and ask if you want to zero the pressure.
2. Press A, B, C, or D to zero the desired pump.

   or,

   If the pump is not depressurized, press DO_NOT (D) to exit the zero pressure operation. If four pumps are connected press the STORE, RECALL OR CLEAR ENTRY key.

3.9 Control of Multiple Pumps

When using multiple pumps, there are two multi-pump operating modes of delivery and one independent mode:

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

3.9.1 Multi-Pump Operation

A HL_f Series continuous flow pumping system in constant flow mode will consist of two syringe pumps and a valve package, all regulated by one controller. Installation and operating instructions for this system are provided in **Section 5**.

In these modes, 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. Sets the NVC feature On/Off.

3.9.2 Independent Control of up to Four Separate Pumps

A HL_f Series syringe pump controller can run four syringe pumps independently of each other in either constant pressure, constant flow mode, dispense mode, or any combination of the three. To set up this option, use the following procedure.

1. Press MENU.

2. Press softkey A, MORE.
3. Press number 4, MULTI PUMP. The multi-pump menu will appear.
4. Press number 1 for pumps A or B, press number 2 for pumps C or D.
5. Press number 4, INDEPENDENT. The controller will set the pumps to Independent mode. Number 4 will blink, indicating that INDEPENDENT mode is selected.
6. Select the HOLD PRESS or NORMAL mode of operation. Press softkey A to toggle between the two modes.

   HOLD PRESS: In constant pressure mode, after the pump is empty, 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 system down if a pump 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. Independent mode is the default setting for the pump.

   When you select a command such as STOP or REFILL, the display will prompt you to designate which pump to stop or refill. Only the designated pump will stop; the other pumps will continue to run.
7. Return to the run screen by pressing D three times. Then press D (SELECT PUMP). The display will show each pump's information and allow you to select any pump for programming changes.

3.10 Operating Modes

The pump has three delivery modes and one refill mode.

> ☑ ***Note***
>
> When using a single controller to operate multiple pumps independently, you need to select the appropriate pump run screen before selecting a mode. To select the appropriate pump, press SELECT PUMP (D) and an intermediate screen will be shown. Press the softkey for the appropriate pump, the run screen for that pump will appear.

Constant Flow – Refer to Section 3.10.1

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

Constant Pressure – Refer to Section 3.10.2

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.

Programmed Gradient – Refer to Section 4

In the programmed gradient mode, the pump can provide the following types of gradient:

- Two-pump concentration gradient on pumps A and B
- Single-pump linear pressure gradients on pump A
- Single-pump flow programs on pump A

Dispense – For applications requiring delivery of a specific volume. Refer to Section 3.10.3.

Refill – Refer to Section 3.4.3.

You can set the refill rate and change it when in refill mode.

3.10.1 Constant Flow

To set constant flow operation, use the following procedure:

1. Press CONST FLOW. “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, C, or D, press softkey D, select pump, and then press softkey A, B, C, or D to select pump A, B, C, or D respectively.

> ☑ ***Note***
>
> If the main menu is displayed, you must press D under CONST FLOW.

2. Press A 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 CLEAR ENTRY to delete one character at a time.

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

3.10.2 Constant Pressure

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

1. Press CONST PRESS; 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, C, or D press softkey D, select pump, and then press softkey A, B, C, or D to select pump A, B, C, or D respectively.

Note

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

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 CLEAR ENTRY to delete one character at a time.

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

3.10.3 Dispense Mode

For applications such as reactant feed and batch delivery where a specified volume is pumped, Dispense Mode is available with Teledyne ISCO syringe pumps.

Dispense mode flow rate begins at zero, ramps up to level out at the programmed flow rate, then ramps back down to zero, delivering a precise specified volume. The slope rate and run time are dependent upon the pump model being used.

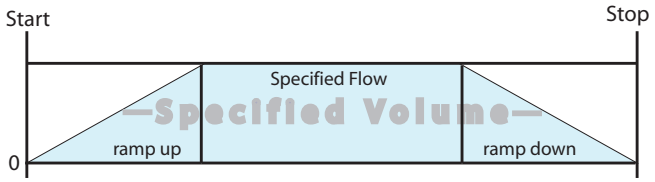


Figure 3-10 Depiction of dispense mode sequence

Note

For time-controlled delivery, you must run the pump in standard gradient mode, as described in Section 4.

In order to access Dispense Mode control, the pump must be in Constant Flow mode. Press CONST FLOW to enter this mode. Toggle Dispense Mode off or on by pressing DISP. Note that pressing the DISP key while in Constant Pressure mode has no effect.

To adjust the flow rate, press FLOWRATE (A), enter the desired rate using the number keys, and press ENTER.

To specify the volume of the batch delivered, press VOLUME (C), enter the desired volume using the number keys, and press ENTER.

To dispense the batch, press RUN. The sequence runs once, then stops. To repeat the sequence, press RUN again.

☑ Note

When the system is in Dispense Mode, all gradient modes, constant pressure mode, and auto-refill, as well as serial control, are unavailable until Dispense Mode is turned off.

3.11 External Control

The pump can be externally controlled for pressure or flow rate operation with an analog voltage or through the serial interface.

The serial interface allows you to control the pump operation from an IBM-PC or compatible computer that 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 7 *Serial Interface*.

3.12 External Control: Analog

The 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.

⚠ WARNING

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

3.12.1 Wire connections

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.

If four pumps are used with the controller, the fourth analog control or input wire should be connected to terminal 4 under ANALOG INPUT.

When using one of the multi-pump operation modes, only the ANALOG INPUT terminal 1 needs to be connected to control the A-B pump pair and ANALOG INPUT terminal 3 needs to be connected to control the C-D pair.

Resistors

HLf 4-20mA syringe pump controllers manufactured after September 2023 include two external 499 ohm, 1/2 W, 1% tolerance resistors with insulated leads. One resistor is installed between the digital input 3 and +15 V accessory terminals; the other resistor is installed between the digital input 4 and +15 V accessory terminals.

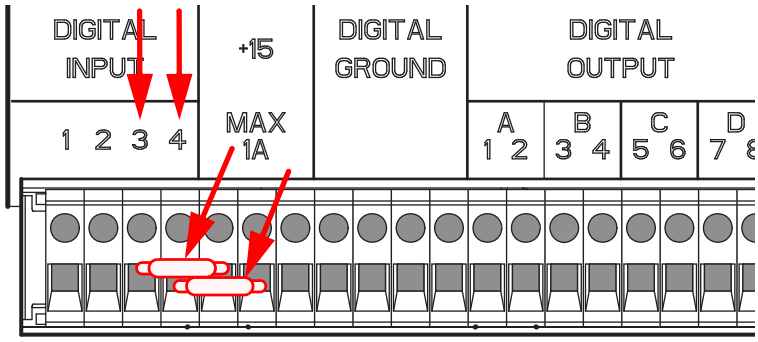


Figure 3-11 External resistor locations

For proper operation, these resistors are required when only pump A or pumps A and B are connected. However, some pump configurations will require removal of one or both of these resistors as indicated by a blank "Resistor digital input" entry in the following table.

Table 3-2 External Resistor Configuration

Pump(s) connected				Resistor digital input	
A	B	C	D	3	4
X				X	X
X	X			X	X
X	X	X			X
X		X			X
X			X	X	
X		X	X		
X	X	X	X		

3.12.2 Preparation

Before programming the controller to accept the analog signal, you must know the maximum flow rate (constant flow) or the maximum pressure (constant pressure).

Note

The high and low limits you enter cannot exceed the pump specifications: Normal input = 10V.

To determine the analog voltage range, use the formula explained below:

$$FS \times \left(\frac{V}{U}\right) = Vmax$$

where:

FS = Maximum flow rate or Maximum pressure (Full Scale): This is the same value entered when setting LIMITS, as described in Section 3 of your user manual, for MAX PRESS or MAX FLOW.

V = Volts per unit of flow or pressure

U = Incremental unit of flow or pressure

Vmax = Maximum input voltage

3.12.3 External Control for Refill

The refill option allows you to set the refill rate, or set the pump to automatically refill when a certain volume is reached. From Menu 2, the system can be programmed to automatically refill a pump based on an external analog signal, with a range of 0 to 11.5 volts.

To access this feature, press MENU > MORE (A) > EXTERNAL (3).

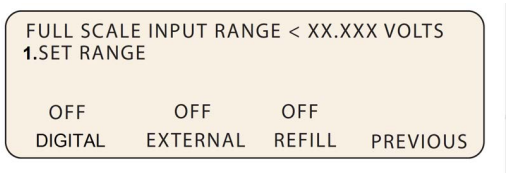


Figure 3-12 External control menu

- To set the full-scale value (maximum 11.5 volts), press SET RANGE (1), enter the desired value, and press ENTER.
- To place the pump under external control, press EXTERNAL (B). The feature will turn from OFF to ON.
- To enable remote RUN/STOP control, press DIGITAL (A). This feature will turn from OFF to ON.
- To set the external control for refill, press REFILL (C). The feature will turn from OFF to ON.

3.12.4 Calculation Examples

Flow Rate – If MAX FLOW is set at 25 ml/min in the LIMITS menu and the desired scale factor is 5.0 volts per 20 ml/min, do the following to determine the analog voltage range:

$$25 \times \left(\frac{5}{20}\right) = 6.25$$

In this example, the analog voltage range would be 0.0–6.25 volts.

Pressure – If MAX PRESS is set at 510.2 ATM in the LIMITS menu and the desired scale factor is 2.0 volts per 100 ATM, do the following to determine the analog voltage range:

$$510.2 \times \left(\frac{2}{100}\right) = 10.204$$

In this example, the analog voltage range would be 0.0–10.204 volts.

3.12.5 Setup

First, select the desired operating mode by pressing CONST PRESS or CONST FLOW.

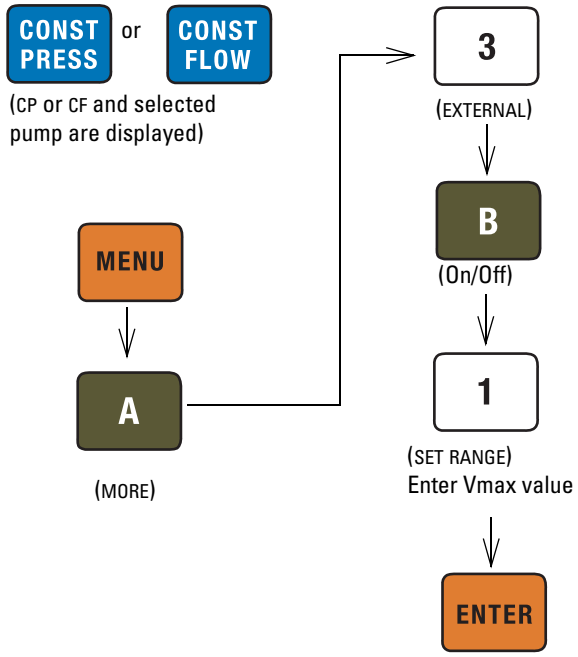


Figure 3-13 Button sequence for external control setup

3.13 Remote RUN/STOP

The HLf 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 enable the remote RUN/STOP feature, press MENU > MORE> (A) > EXTERNAL > (3) > DIGITAL (A) "On". Then 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.

⚠ WARNING

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

3.13.1 Wire Connections

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.

If four pumps are used with the controller, the fourth control wire should be connected to terminal 4, under DIGITAL INPUT.

HL_f Series Syringe Pumps

Section 4 Gradient Pumping for Pressure, Flow, and Concentration Modes

4.1 Introduction

Gradient pumping is used in applications requiring time-controlled or rate-controlled delivery of a specific volume at a set flow rate or pressure, or a two-pump flow concentration.

You can program the controller to increase or decrease pressure or flow during different steps within a single program by entering a specific value at the beginning and end of each step.

⚠ DANGER

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

Tools and Parts for Single Pump System

Open-end wrenches: 1/4", 5/16", 7/16", 3/8"

Manual Refill Valve Kit - see Table 4-1

Manual Outlet Valve Kit - see Table 4-2

Tools and Parts for Dual Pump System

Open-end wrenches: 1/4", 5/16", 7/16", 3/8"

Manual Refill Valve Kit -
see Table 4-1 (two kits required)

Table 4-1 Manual Refill Valve Kits

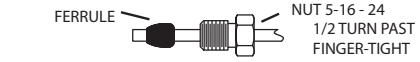
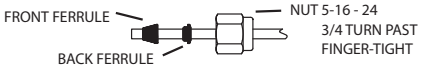
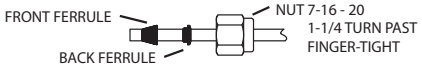
Pump Model	Part Number
$1000HL_f$	68-1247-117
$500HL_f$	68-1247-083
$100HL_f$, $260HL_f$	68-1247-077

Table 4-2 Manual Outlet Valve Kits	
Pump Model	**Part Number**
$1000HL_f$	68-1247-118
$500HL_f$	68-1247-082
$100HL_f$, $260HL_f$	68-1247-078

4.2 Connecting the System

The syringe pump has two ports at the top of the cylinder. One port is used as the inlet for filling the pump, and the other as the outlet (either port may be used as inlet or outlet). Inlet and outlet connections to each pump must be made identically. Standard plumbing connections vary between pump models. See Table 4-3 for standard port information.

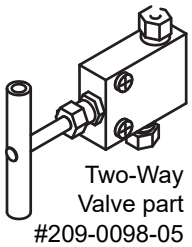
When making fluid connections that use ferrules, be sure to use the ferrules supplied for that pump by Teledyne ISCO. Push the tubing completely into the connector and finger-tighten. Then tighten with a wrench to clamp the ferrules onto the tubing.

Table 4-3 Swaging Detail		
$100HL_f$ $260HL_f$	1/8" Valco	
$500HL_f$	1/8" NPT	
$1000HL_f$	1/4" NPT	

☑ *Note*

Pump models $260HL_f$ and $100HL_f$ have a direct connection, as shown in Figures 4-1 and 4-2 on the following page. Valve kits for other models include male adapter fittings.

A gradient pumping system includes high-pressure, two-way valves that connect the pump inlets to fluid reservoirs, and the pump outlets to the gradient mixer (dual pump system) or other apparatus (single pump system). Each refill kit and outlet valve package contains one two-way valve; the gradient package contains two. The kits contain all tubing and hardware necessary for valve installation.



Two-Way Valve part #209-0098-05

Following installation, the tubing connections must be tested for leaks before any program is run. If a leak is found, tighten the connection slightly. If the leak persists, swage the connection again with a new ferrule. Refer to Technical Bulletin TB05 Field Verification Procedures at http://www.isco.com/sp_applications/#techbulletins for leak test procedures.

4.2.1 Inlet Connections

Kit components and connections are shown in Figure 4-1.

1. Mount the inlet valve on the pump housing with the spacer block and screws provided.
2. Connect the pre-bent SST tubing from one port of the valve to the pump inlet. Use the nut and ferrule to connect the tubing at the inlet and the valve fittings to connect the tubing at the valve.
3. Connect the PTFE refill tubing (with the filter) to the other port of the valve, using the nuts and ferrules supplied.

☑ Note

When connecting to pressurized sources in supercritical fluid applications, use the stainless steel tubing **without** a filter. An in-line filter is contained in the CO_2 connection package (refer to technical bulletin TB08 CO_2 Applications and Technical Notes at http://www.isco.com/sp_applications/#techbulletins).

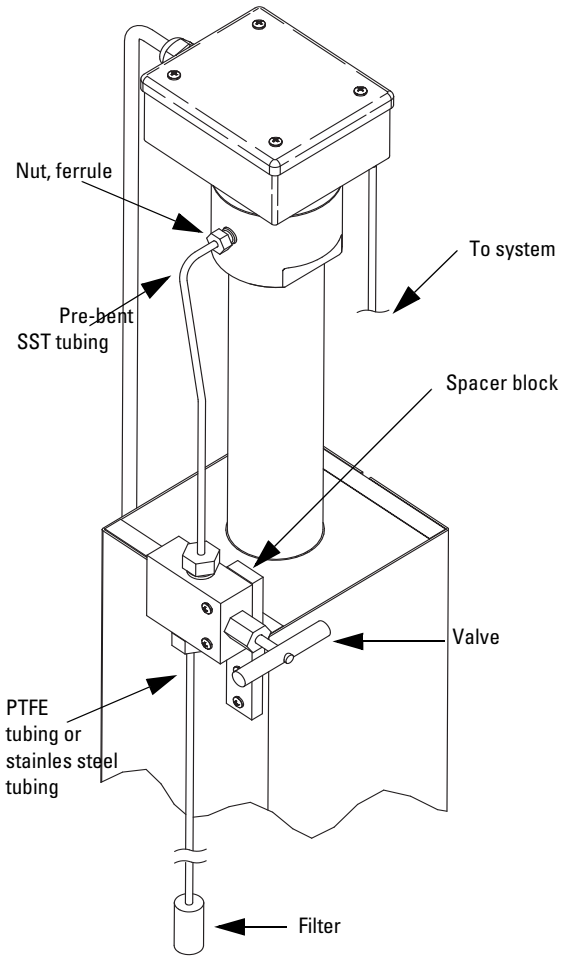


Figure 4-1 Pump inlet connections

4.2.2 Outlet Connections

Kit components and connections are shown in Figure 4-2.

1. Mount the two-way outlet valve on the side of the pump housing opposite the refill valve, with the spacer block and screws provided.
2. Connect the pre-bent SST tubing between one port of the valve and the pump outlet. Use the nut and ferrule to connect the tubing at the outlet and the valve fittings to connect the tubing at the valve.
3. Connect the 5.1 cm length of $\frac{1}{8}$" tubing to the other port of the valve, using the valve fittings.
4. Connect the $\frac{1}{8}$" side of the reducing union to the tubing.
5. Connect the $\frac{1}{16}$" side of the reducing union to the 1.5 m length of $\frac{1}{16}$" tubing. (This tubing may be cut to an appropriate length.)

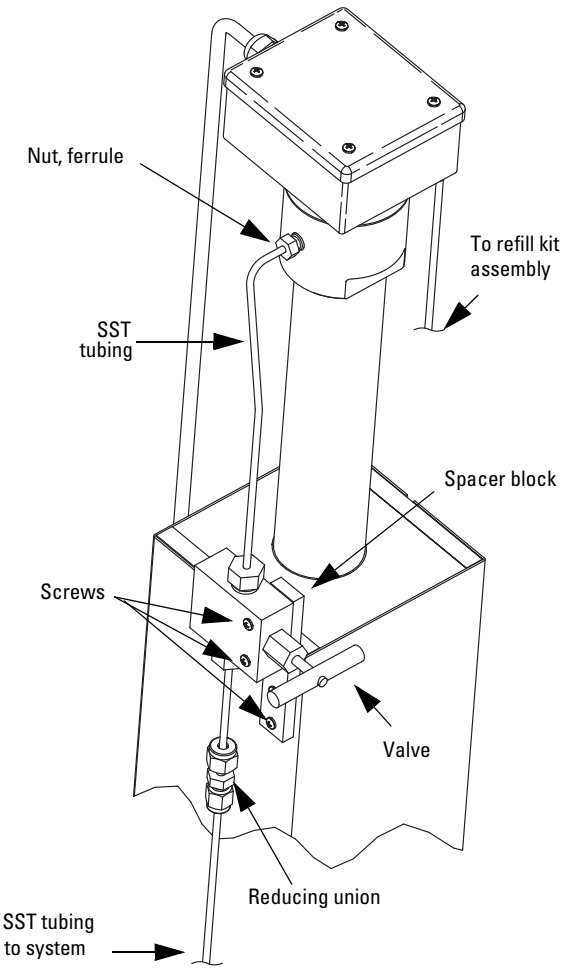


Figure 4-2 Pump outlet connections

4.3 Single-Pump Gradient Programming

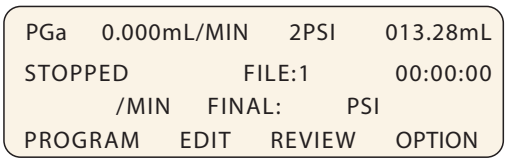
A single-pump gradient program is based on either pressure or flow, and controlled by either time duration (in minutes) or rate of change (units per minute).

The controller's memory can contain a total of up to 200 steps. One program can contain from 1 to 200 steps.

When operating in gradient mode, any connected pumps not used for gradient are inoperable.

1. To access the gradient programming menus, press PRGM GRAD, select PRESSURE (2) or FLOW (3), and CONTINUE (C).

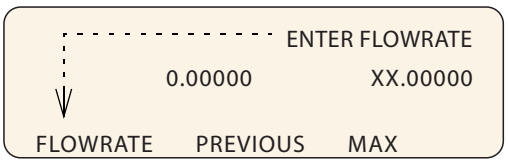
   The home screen will appear, with either PG (Pressure Gradient) or FG (Flow Gradient) in the upper left corner.



2. Press PROGRAM (A).
3. At the prompt, enter a file number between 1 and 99. This is the file name of your program, and can be the name of a new program you are creating, or a stored program you want to edit or run. Press ENTER.

> ☑ ***Note***
>
> If a selected stored program is in a different mode than that of the controller selected in Step 1, a brief notification will appear, displaying the controller's mode and the file's mode. If you attempt to run the program without changing the mode of either it or the controller, the program will not run, and the same message will be displayed.

4. To enter the flow rate for this program, either press FLOWRATE (A) and use the number keys and Enter, or for maximum possible flow, simply press MAX (C).



5. To proceed to the programming screen, press STEP FWD (B).
   The programming screen will appear, with the file number and step number at the top of the screen.

```
PGa   FILE# 1    STEP# 1   STORE TO EXIT
1. INIT =   0PSI  3. RATE =   0:00PSI/MIN
2. FINAL =  0PSI  4. DURATION =  1.0MIN
                      INSERT      DELETE
```

or

```
FGa   FILE# 1    STEP# 1   STORE TO EXIT
1. INIT% =          3. RATE =  0.00%/MIN
2. FIN% =           4. DURATION = 1.0MIN
                      INSERT      DELETE
```

6. To set the initial pressure or flow for this step, press INIT (1) to activate this parameter. Use the number keys to enter the desired value, then press ENTER to save it.
7. To set the final pressure or flow for this step, press FINAL (2) to activate this parameter. User the number keys to enter the desired value, then press ENTER to save it.
8. Set either the desired RATE (3) of change or DURATION (4) in minutes. Once one value has been set and saved, the other will automatically appear.

☑ Note

DURATION in minutes can have a resolution of 0.1, with a maximum of 9,999 minutes per step.

9. If you want to add another step to the file program, press INSERT (C).
10. The step number will increase by one, and the default initial value will be the final value entered for the previous step. Edit as desired.
11. When programming is complete, press the STORE key to save the file and return to the home screen.
12. To start the program, press RUN two times.

☑ Note

When a gradient run is started, digital output **8** of the controller ACCESSORY connector will toggle from high to low (open to closed) for one second.

Note that an entire gradient program can be removed only by deleting each of its steps one at a time, as discussed in Section 4.5 *Review, Revise, & Hold Options*. When the last remaining step is deleted, the entire file is removed.

4.4 Dual Pump Concentration Gradient Programming

Two-pump concentration gradients enable proportionate use of two different fluids that combine at the mixer (refer to Figures 4-1 and 4-2).

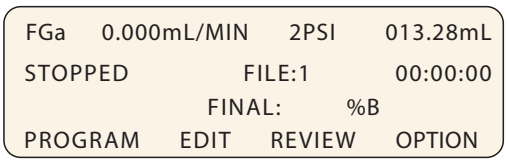
This type of pumping uses flow mode (FG) only. A single-pump gradient program is based on either pressure or flow, and controlled by either time duration (in minutes) or rate of change (units per minute).

The controller's memory can contain a total of up to 200 steps. One program can contain from 1 to 200 steps.

When operating in gradient mode, any connected pumps not used for gradient are inoperable.

1. To access the gradient programming menus, press PRGM GRAD, then DUAL SYSTEM GRADIENT (1) and CONTINUE (C).

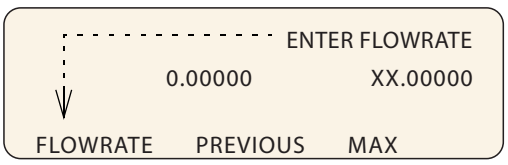
   The home screen will appear, with FG (Flow Gradient) in the upper left corner.



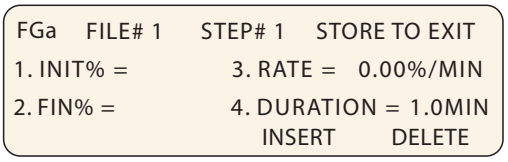
2. Press PROGRAM (A).
3. At the prompt, enter a file number between 1 and 99. This is the file name of your program, and can be the name of a new program you are creating, or a stored program you want to edit or run. Press ENTER.

> ☑ ***Note***
>
> If a selected stored program is in a different mode than that of the controller selected in Step 1, a brief notification will appear, displaying the controller's mode and the file's mode. If you attempt to run the program without changing the mode of either it or the controller, the program will not run, and the same message will be displayed.

4. To enter the flow rate for this program, either press FLOWRATE (A) and use the number keys and Enter, or for maximum possible flow, simply press MAX (C).



5. To proceed to the programming screen, press STEP FWD (B).
   The programming screen will appear, with the file number and step number at the top of the screen.



6. To set the initial pressure or flow for this step, press INIT (1) to activate this parameter. Use the number keys to enter the desired value, then press ENTER to save it.
7. To set the final pressure or flow for this step, press FINAL (2) to activate this parameter. User the number keys to enter the desired value, then press ENTER to save it.
8. Set either the desired RATE (3) of change or DURATION (4) in minutes. Once one value has been set and saved, the other will automatically appear.

☑ *Note*

DURATION in minutes can have a resolution of 0.1, with a maximum of 9,999 minutes per step.

9. If you want to add another step to the file program, press INSERT (C).
10. The step number will increase by one, and the default initial value will be the final value entered for the previous step. Edit as desired.
11. When programming is complete, press the STORE key to save the file and return to the home screen.
12. To start the program, press RUN two times.

☑ *Note*

When a gradient run is started, digital output **8** of the controller ACCESSORY connector will toggle from high to low (open to closed) for one second.

The flow rates and ramp rate for Pump A in each step will be in direct opposite proportion to the values set for Pump B (INIT%B, FIN%B, and RATE).

Note that an entire gradient program can be removed only by deleting each of its steps one at a time, as discussed in the next section, 4.5 *Review, Revise, & Hold Options*. When the last remaining step is deleted, the entire file is removed.

4.5 Review, Revise, & Hold Options

While in the programming menu, you can also:

Delete – To delete the current step, press DELETE (D). A deleted step cannot be recovered. Used repeatedly, this command can be used to delete an entire file.

Review – To review existing program steps, press STEP BACK (A) or STEP FWD (B).

Add New – To add a new step between two existing steps, navigate through the program to the step just before your addition. Press INSERT (C) and program the new step.

Note that the initial value of the next step will default to the final value of the new step, and may need to be edited if a different initial value is needed.

While Running – A gradient program can be reviewed or edited while it is running. Simply press EDIT (B) or REVIEW (C) to begin. If a new step duration is shorter than the elapsed time for that step, the program will proceed to the next step. If the total flow rate is changed, the program will immediately start using the new rate.

To return to the run screen, press RETURN (D).

Hold – You can hold a running gradient in its current state while retrieving a different program file to run in its place. Press Hold and then Recall to access the new program.

This feature is used mainly in applications where it is necessary to keep the system pressurized during method changes.

External Start – When a gradient program is in Hold mode, a momentary low on digital input **2** of the controller ACCESSORY connector will start the program.

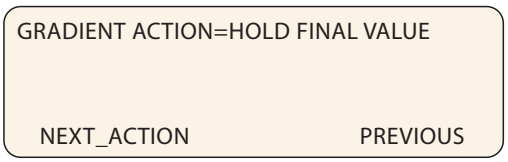
4.6 Program Conclusion

When a gradient program reaches the end, there are four selectable actions the system can then perform:

- Hold the final value *(example below)*
- Stop after the final step
- Return to the initial value and hold it
- Return to the initial value and repeat the program

While the system is in gradient mode, these options can be edited at any point before or after gradient programming, and while a gradient is running.

To access the options menu, from the home screen, press OPTIONS (D).



To scroll through the four options, press NEXT_ACTION (A). When you have reached the desired option, press PREVIOUS (D) to save and exit.

HL_f Series Syringe Pumps

Section 5 Continuous Flow Introduction, Installation, & Operation

5.1 Introduction

A 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 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, with the exception of continuous Receive Mode (for detailed information about Receive Mode, refer to technical bulletin TB02 Constant Pressure Pump Operation for Receive Mode, available on the Teledyne ISCO web site).

In any syringe pump continuous flow system, a flow irregularity occurs at the time of switch over from one pump module to the other. This flow irregularity can be measured as a pressure fluctuation. Teledyne 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.

5.2 Continuous Flow Air Valves

Air valves generally open and close faster and are less prone to error and component wear, making them suitable for industrial use and other applications where the system will be constantly running; however, they require a user-supplied pressurized air source of 80 to 115 psi (5.5 to 7.9 bar).

Air Valve Package Numbers

For 1000 HL_f Systems	60-1247-143
For 500HL_f Systems	60-1247-142
For 100HL_f and 260HL_f Systems	60-1247-141

Table 5-1 Continuous Flow Technical Specifications-Air Valves:	
Pressure fluctuation at switchover during delivery	5 psi (0.35 bar), at system backpressures from 100 psi (6.9 bar) to the single pump maximum. Higher fluctuation occurs at pressures below 100 psi.
Minimum	50.76 psi (3.5 bar)
Maximum system backpressure	The single pump maximum. Valves rated to 10,000 psi (689.5 bar)
Air supply source pressure	80 to 115 psi (5.5 to 7.9 bar)
Maximum flow rate (ml/min)	
Liquids: 65% of the single pump maximum rate.	$1000HL_f$ 265.2 $500HL_f$ 132.6 $260HL_f$ 69.55 $100HL_f$ 32.50
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 PTFE
Tubing and fittings	SS316, gold

5.2.1 Dual Air Valve Installation

To install the air valve package (refer to Figure 5-1or 5-3, depending on your pump model):

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

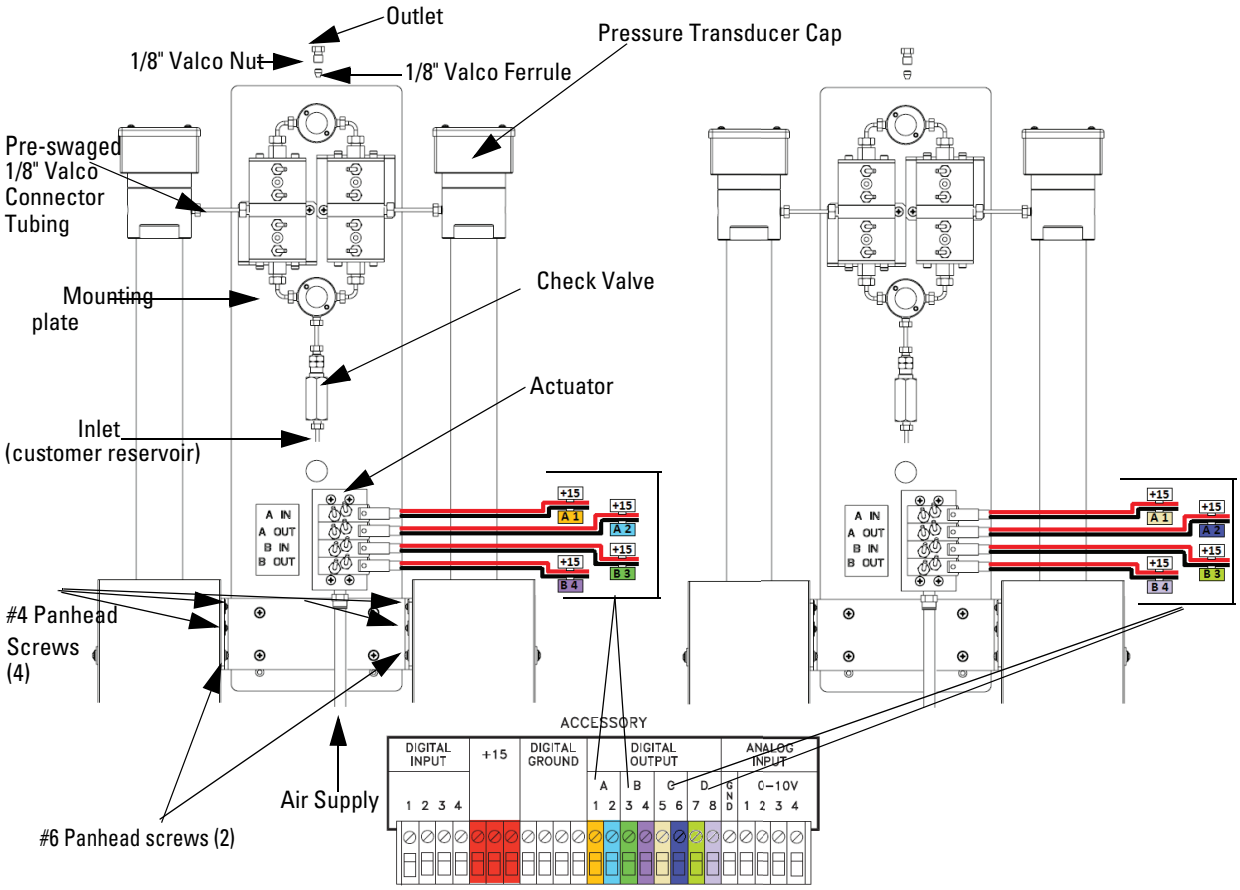
⚠ DANGER

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. Install the four #4 panhead screws on bottom of the bracket and the two #6 panhead screws.

Plumbing connections

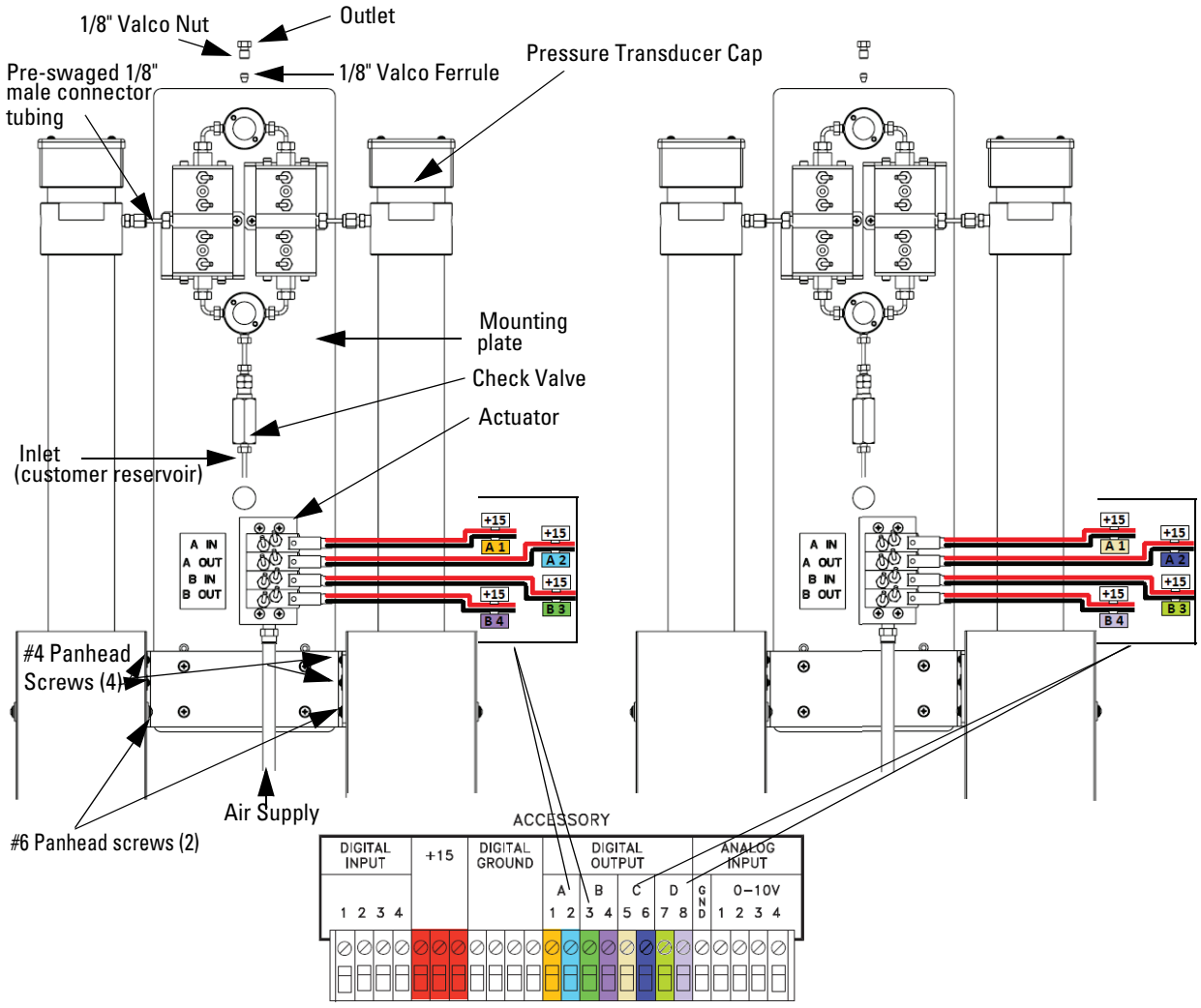
5. Tighten the tubing nuts.
6. Connect the inlet tube to the supply reservoir. Connect the outlet tee to your apparatus.



Wire pair conversion table for A-B Pump Pair and C-D Pump Pair

A-B Pump Wire Pair	Digital Output	+15 Wires		C-D Pump Wire Pair	Digital Output	+15 Wires
A1	A1	+15		A1	C5	+15
A2	A2	+15		A2	C6	+15
B3	B3	+15		B3	D7	+15
B4	B4	+15		B4	D8	+15

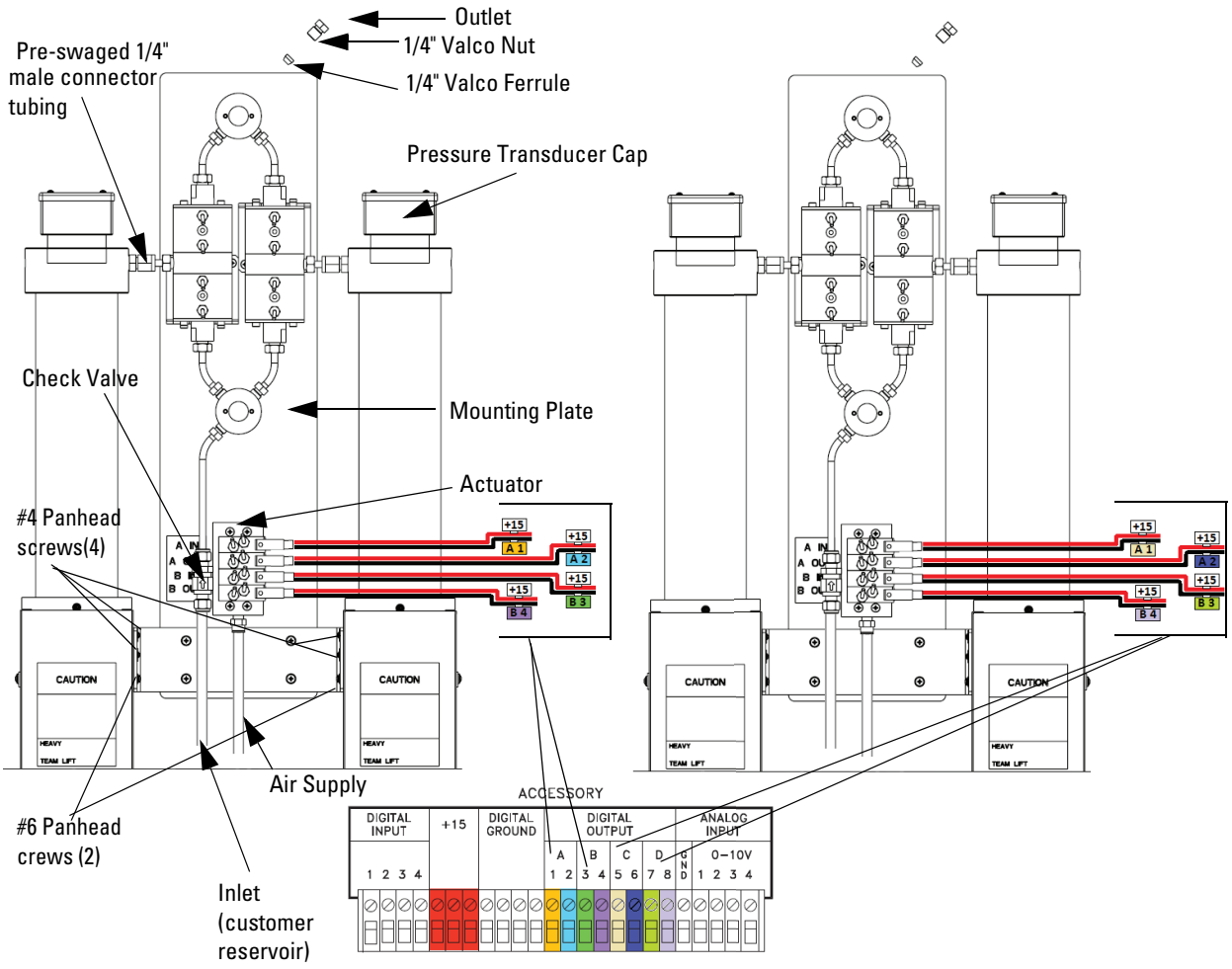
Figure 5-1 Air valve installation for 100HL$_f$ and 260HL$_f$ pumps



Wire pair conversion table for A-B Pump Pair and C-D Pump Pair

A-B Pump Wire Pair	Digital Output	+15 Wires		C-D Pump Wire Pair	Digital Output	+15 Wires
A1	A1	+15		A1	C5	+15
A2	A2	+15		A2	C6	+15
B3	B3	+15		B3	D7	+15
B4	B4	+15		B4	D8	+15

Figure 5-2 Air valve installation for 500HLf



Wire pair conversion table for A-B Pump Pair and C-D Pump Pair

A-B Pump Wire Pair	Digital Output	+15 Wires		C-D Pump Wire Pair	Digital Output	+15 Wires
A1	A1	+15		A1	C5	+15
A2	A2	+15		A2	C6	+15
B3	B3	+15		B3	D7	+15
B4	B4	+15		B4	D8	+15

Figure 5-3 Air valve installation for 1000HL$_f$ pump

5.3 User Supplied Valves

Users may also choose to supply their own valves. The following information is necessary to choose the appropriate valves to work with Teledyne 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 Teledyne 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 5-2 shows 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 5-2 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)
5	C	Inlet (open or closed)
6	C	Outlet (open or closed)
7	D	Inlet (open or closed)
8	D	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 con-

nected 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.

5.4 Continuous Flow Mode

Once your valve package has been properly installed and you have ensured that fluid connections are leak-free, the system is ready for operation.

> ☑ ***Note***
>
> Teledyne 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 Teledyne ISCO air valve package is used, the air valves are switched through ACCESS CTRL. When air valves are used, lights on the air valve actuator indicate which valves are open.

Table 5-3 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	OTHER OPTIONS	Sets the fill and refill marks that are used with both continuous flow modes. Sets the NVC feature On/Off.

5.4.1 Defining Operation

Select Pump – This menu allows you to select any pump to display its run screen (program and operation data) and to make program changes.

Valve specification – To prevent pressure fluctuation at switchover, you must specify the type of valve package you are using.

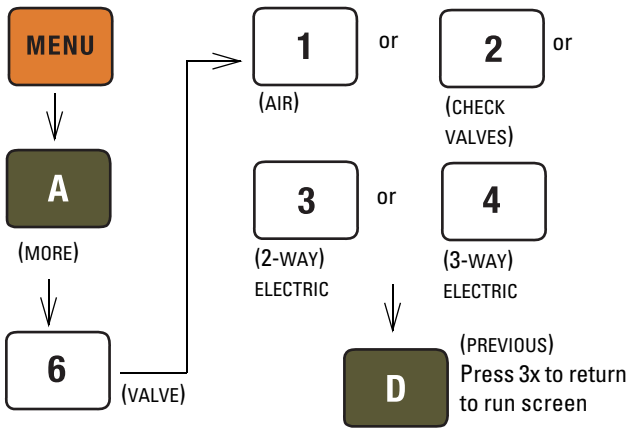


Figure 5-4 Keystrokes to specify valve type

Note

In Figure 5-4 *Active* refers to air or electric valves; *Passive* refers to check valves.

Volume totalizer – The total volume delivered is displayed in liters at the top right corner of the screen. Refer to the figure below to reset the volume totalizer to zero.

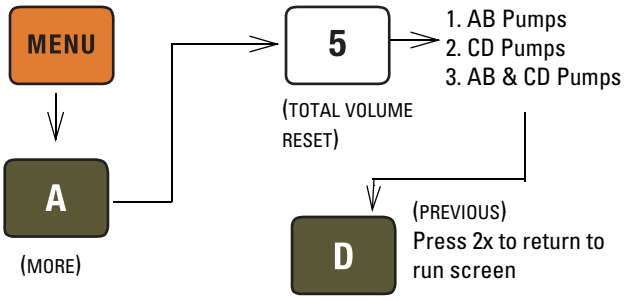


Figure 5-5 Keystrokes to reset volume totalizer

5.4.2 Constant Flow Mode

Continuous flow mode is found under the multi-pump options on Menu 2. Once you have accessed the multi-pump options, you may select Constant Flow mode or Constant Pressure mode.

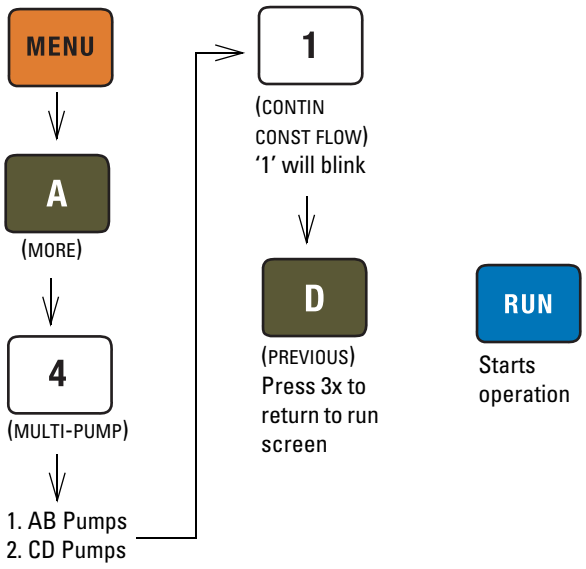


Figure 5-6 Keystrokes to set up constant flow

5.4.3 Constant Pressure Mode

Continuous flow mode is found under the multi-pump options on Menu 2. Once you have accessed the multi-pump options, you may select Constant Flow mode or Constant Pressure mode.

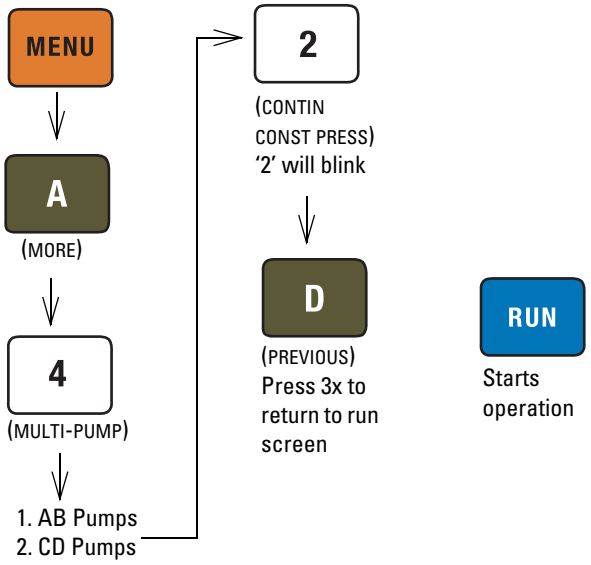


Figure 5-7 Keystrokes to set up constant pressure

5.4.4 To Run or Stop

This menu setting allows the operator to run or stop both pairs of pumps simultaneous.

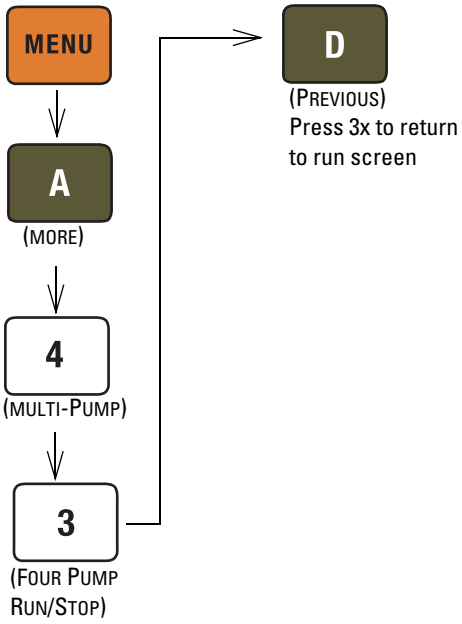


Figure 5-8 Keystrokes to Run or Stop the pumps

> **Note**
> Before pressing RUN, ensure that ON CONT FLOW is displayed on the screen, and that the set flow rate/pressure is correct.

Always verify the valve settings before running a program. If a controller is reset or moved to a different power source, it will revert back to default settings (Active).

5.4.5 Tips for Running Continuous Flow

Liquids Checklist:

1. Degas liquids if appropriate.
2. Purge air from the system:
   a. Fill both pumps completely by pressing REFILL and selecting each pump to fill.
   b. Route the outlet to waste or reservoir and press RUN. Press STOP when fluid comes out of the outlet.
   c. Open the valves to atmosphere by pressing ACC CTRL, then selecting each valve to open.
   d. Zero the pressure in each pump by pressing ZERO PRESS and selecting each pump to zero.
   e. Connect the outlet tubing and fill each pump once more.
3. Reset total volume (see Figure 5-5).

Liquefied Gases Checklist:

1. Open the valves to atmosphere by pressing ACC CTRL, then selecting each valve to open.
2. Zero the pressure in each pump by pressing ZERO PRESS and selecting each pump to zero.
3. Fill both pumps completely by pressing REFILL and selecting each pump to fill.
4. Pressurize both pumps by pressing RAPID PRESS. Maximum flow rate and target pressure value will be displayed. Press D to continue pressurization.
5. Reset total volume (see Figure 5-5).

Equilibration – When the pumps begin running, the system will go through an equilibration phase, during which both pumps must be full and delivering fluid.

Additional guidelines – Please become familiar with the following guidelines:

- Pressure limits for continuous constant flow mode are set by the limits of pump A for the A-B pair and pump C for the C-D pair.
- Temperature changes can cause pressure fluctuations. For available temperature control options, contact Teledyne ISCO.
- For correct overpressure response, shutdown must be set to ON under PUMP LIMIT options.
- Enter the same refill rate separately for pumps A, B, C, and D.
  The refill rate should always be as high as possible to allow time for refill and repressurization before the next switchover.

HL_f Series Syringe Pumps

Section 6 Modbus Configuration

6.1 Overview

Modbus is a simple command/response mechanism to read from and write to specific memory locations called *registers*. A register is a holding place for a piece of digital information within the equipment. For more information on Modbus, please refer to the following documents which can be found on the www.modbus.org website: Modbus Application Protocol Vol. 1 and Modbus Over Serial Line Vol. 1[2] and Modbus Messaging on TCP/IP.

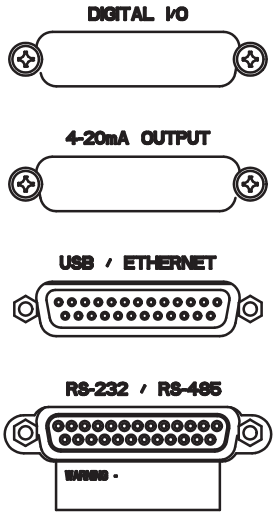
The ISCO HL_f Series Syringe pump controller supports both the Modbus RTU and Modbus TCP/IP protocols.

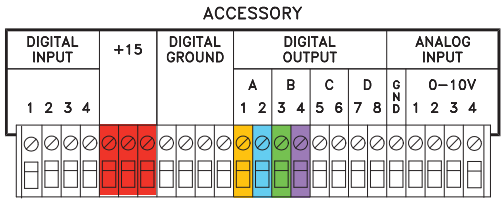
6.1.1 Modbus RTU

The Modbus RTU protocol implementation uses a 2-wire RS-485 connection. The RS-485 connections are located on the DB25 connector labeled RS-232/RS-485. We recommend connecting the ground reference wire as shown in Figure 6-1. The matching connection is a D-Subminiature 25-pin standard plug, such as an AMP part #747912-2 from an electronic parts supplier.

⚠ WARNING

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





Pin on DB25-shell	RS-485 2-Wire
18	DATA (B)+
11	DATA (A)-
7	GND

Figure 6-1 RS-485 Connection

6.1.2 Modbus TCP/IP

The modbus TCP/IP protocol implementation uses an ethernet connection. The ethernet connections are located on the DB25 connector labeled USB/Ethernet.

Pin on DB 25 Casing	Ethernet
2	Transmit +
14	Transmit -
15	Receive +
17	Receive -

6.1.3 Modbus Configuration Options

To access the Modbus configuration settings, press:

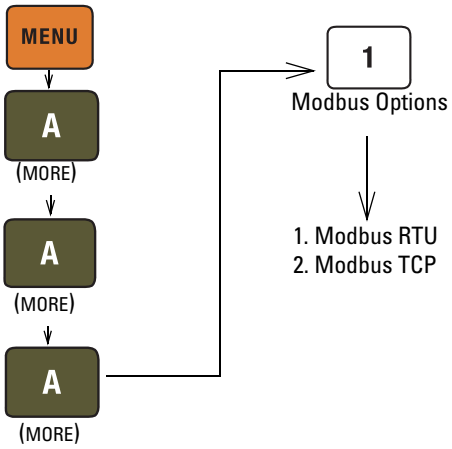


Table 6-1 Modbus TCP/IP Configuration Options

Item	Description
IP Address	Internet protocol address of device (Default 192.168.1.200)
Subnet Mask	Subnet mask (Default 255.255.255.0)
Gateway	Gateway (Default 0.0.0.0)
Port	TCP port (Default 502)

Table 6-2 Modbus RTU Configuration Options

Item	Value	Description
Baud Rate	300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	Communication Speed (Default 19200)
Slave ID	1-247	Device address (Default 1)
Parity	Even 1 Stop Bit, Odd 1 Stop Bit, None 1 Stop Bit, None 2 Stop Bit	Communication parameters (Default Even 1 Stop Bit)
Word Order	Big Endian, Little Endian	Word order for 32-bit integers and IEEE-754 floating point numbers. Big Endian: AB CD; Little Endian CD AB. (Default Big Endian)
Character Time	Min: Baud Rate dependent Max: 999ms	Time to transmit single character t1. Used to calculate inter frame and inter character space t1.5, t3.5 (50 m sec default)

Table 6-3 Supported Modbus Function Codes

Function Code	Description
01	Read Discrete Output Coils
03	Read Analog Output Holding Registers
05	Write Single Discrete Output Coil
15	Write Multiple Discrete Output Coils
16	Write Multiple Analog Output Holding Registers

Table 6-4 Exception Responses

Exception Code	Name	Description
01	Illegal Function	Function code received is not supported.

Table 6-4 Exception Responses (Continued)		
02	Illegal Data Address	Data address received is not an allowable address.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the addressed location. This may indicate a fault in the structure of the remainder of a complex request, such that the implied length is incorrect. Does NOT mean data value is outside the expectation of the controller.

Table 6-5 Coils

Register	Address	Type	Size	Description
00001	0	R/W	1 BIT	0: Stop Pump A 1: Run Pump A
00002	1	R/W	1 BIT	0: Stop Pump B 1: Run Pump B
00003	2	R/W	1 BIT	0: Stop Pump C 1: Run Pump C
00004	3	R/W	1 BIT	0: Stop Pump D 1: Run Pump D
00005	4	R/W	1 BIT	Link Run/Stop operation of multi-pump pair AB & multi-pump pair CD 0: Disable 1:Enable
00006	5	R/W	1 BIT	0: Stop Pump A if in Refill 1: Run Pump A in Refill
00007	6	R/W	1 BIT	0: Stop Pump B if in Refill 1: Run Pump B in Refill
00008	7	R/W	1 BIT	0: Stop Pump C if in Refill 1: Run Pump C in Refill
00009	8	R/W	1 BIT	0: Stop Pump D if in Refill 1: Run Pump D in Refill
00010	9	R/W	1 BIT	1: Pump A in Constant Pressure mode
00011	10	R/W	1 BIT	1: Pump B in Constant Pressure mode
00012	11	R/W	1 BIT	1: Pump C in Constant Pressure mode
00013	12	R/W	1 BIT	1: Pump D in Constant Pressure mode
00014	13	R/W	1 BIT	1: Pump A in Constant Flow mode
00015	14	R/W	1 BIT	1: Pump B in Constant Flow mode
00016	15	R/W	1 BIT	1: Pump C in Constant Flow mode
00017	16	R/W	1 BIT	1: Pump D in Constant Flow mode
00018	17	R/W	1 BIT	1: Pump A & Pump B in Independent mode
00019	18	R/W	1 BIT	1: Pump A & Pump B in Continuous Flow Constant Flow mode
00020	19	R/W	1 BIT	1: Pump A & Pump B in Continuous Flow Constant Pressure mode
00021	20	R/W	1 BIT	1: Pump A & Pump B in Modifier addition mode
00022	21	R/W	1 BIT	1: Pump A & Pump B & Pump C in Continuous Modifier addition mode
00023	22	R/W	1 BIT	1: Pump C & Pump D in Independent mode
00024	23	R/W	1 BIT	1: Pump C & Pump D in Continuous Flow Constant Flow mode
00025	24	R/W	1 BIT	1: Pump C & Pump D in Continuous Flow Constant Pressure mode
00026	25	R/W	1 BIT	0:Multi-pump pair AB in Delivery mode 1: Multi-pump pair AB in Receive mode

Table 6-5 Coils (Continued)

Register	Address	Type	Size	Description
00027	26	R/W	1 BIT	0: Multi-pump pair AB in Low Press operation 1: Multi-pump pair AB in Normal Press operation
00028	27	R/W	1 BIT	0: Use Fast (coarser) pressure match control for multi-pump pair AB 1: Use Normal (finer) pressure match control for multi-pump pair AB
00029	28	R/W	1 BIT	0: Multi-pump pair CD in Delivery mode 1: Multi-pump pair CD in Receive mode
00030	29	R/W	1 BIT	0: Multi-pump pair CD in Low Press operation 1: Put multi-pump pair CD in Normal Press operation
00031	30	R/W	1 BIT	0: Use Fast (coarser) pressure match control for multi-pump pair CD 1: Use Normal (finer) pressure match control for multi-pump pair CD
00032	31	R/W	1 BIT	1: Activates the automatic rapid pressurization cycle (Constant Flow mode only) for Pump A
00033	32	R/W	1 BIT	1: Activates the automatic rapid pressurization cycle (Constant Flow mode only) for Pump B
00034	33	R/W	1 BIT	1: Activates the automatic rapid pressurization cycle (Constant Flow mode only) for Pump C
00035	34	R/W	1 BIT	1: Activates the automatic rapid pressurization cycle (Constant Flow mode only) for Pump D
00036	35	R	1 BIT	1: Pump A is Equilibrating
00037	36	R	1 BIT	1: Pump B is Equilibrating
00038	37	R	1 BIT	1: Pump C is Equilibrating
00039	38	R	1 BIT	1: Pump D is Equilibrating
00040	39	R	1 BIT	1: Pump A is in Hold (clock stopped)
00041	40	R	1 BIT	1: Pump B is in Hold (clock stopped)
00042	41	R	1 BIT	1: Pump C is in Hold (clock stopped)
00043	42	R	1 BIT	1: Pump D is in Hold (clock stopped)
00044	43	R	1 BIT	1: Pump A & Pump B in Concentration Gradient
00045	44	R	1 BIT	1: Pump A in Pressure Gradient
00046	45	R	1 BIT	1: Pump A in Flow Gradient
00047	46	R/W	1 BIT	1: Controller in Local Operation
00048	47	R/W	1 BIT	1: Controller in Remote Operation
00049	48	R/W	1 BIT	1: Controller in External Operation
00050	49	R/W	1 BIT	1: External Refill control enabled
00051	50	R/W	1 BIT	1: Zero pressure sensor offset for Pump A
00052	51	R/W	1 BIT	1: Zero pressure sensor offset for Pump B
00053	52	R/W	1 BIT	1: Zero pressure sensor offset for Pump C
00054	53	R/W	1 BIT	1: Zero pressure sensor offset for Pump D
00055	54	R/W	1 BIT	0: Pressure Integrator for Pump A OFF 1: Pressure Integrator for Pump A ON
00056	55	R/W	1 BIT	0: Pressure Integrator for Pump B OFF 1: Pressure Integrator for Pump B ON
00057	56	R/W	1 BIT	0: Pressure Integrator for Pump C OFF 1: Pressure Integrator for Pump C ON
00058	57	R/W	1 BIT	0: Pressure Integrator for Pump D OFF 1: Pressure Integrator for Pump D ON
00059	58	R/W	1 BIT	0: Pressure Deadband for Pump A OFF 1: Pressure Deadband for Pump A ON
00060	59	R/W	1 BIT	0: Pressure Deadband for Pump B OFF 1: Pressure Deadband for Pump B ON
00061	60	R/W	1 BIT	0: Pressure Deadband for Pump C OFF 1: Pressure Deadband for Pump C ON
00062	61	R/W	1 BIT	0: Pressure Deadband for Pump D OFF 1: Pressure Deadband for Pump D ON
00063	62	R/W	1 BIT	0: AUTO REFILL A OFF 1: AUTO REFILL A ON
00064	63	R/W	1 BIT	0: AUTO REFILL B OFF 1: AUTO REFILL B ON

Table 6-5 Coils (Continued)

Register	Address	Type	Size	Description
00065	64	R/W	1 BIT	0: AUTO REFILL C OFF 1: AUTO REFILL C ON
00066	65	R/W	1 BIT	0: AUTO REFILL D OFF 1: AUTO REFILL D ON
00067	66	R/W	1 BIT	0: AUTO FILL A OFF 1: AUTO FILL A ON
00068	67	R/W	1 BIT	0: AUTO FILL B OFF 1: AUTO FILL B ON
00069	68	R/W	1 BIT	0: AUTO FILL C OFF 1: AUTO FILL C ON
00070	69	R/W	1 BIT	0: AUTO FILL D OFF 1: AUTO FILL D ON
00071	70	R/W	1 BIT	0: DIGITAL OUTPUT BIT 1 HIGH 1: DIGITAL OUTPUT BIT 1 LOW
00072	71	R/W	1 BIT	0: DIGITAL OUTPUT BIT 2 HIGH 1: DIGITAL OUTPUT BIT 2 LOW
00073	72	R/W	1 BIT	0: DIGITAL OUTPUT BIT 3 HIGH 1: DIGITAL OUTPUT BIT 3 LOW
00074	73	R/W	1 BIT	0: DIGITAL OUTPUT BIT 4 HIGH 1: DIGITAL OUTPUT BIT 4 LOW
00075	74	R/W	1 BIT	0: DIGITAL OUTPUT BIT 5 HIGH 1: DIGITAL OUTPUT BIT 5 LOW
00076	75	R/W	1 BIT	0: DIGITAL OUTPUT BIT 6 HIGH 1: DIGITAL OUTPUT BIT 6 LOW
00077	76	R/W	1 BIT	0: DIGITAL OUTPUT BIT 7 HIGH 1: DIGITAL OUTPUT BIT 7 LOW
00078	77	R/W	1 BIT	0: DIGITAL OUTPUT BIT 8 HIGH 1: DIGITAL OUTPUT BIT 8 LOW
00079	78	R/W	1 BIT	0: Disable Dispense Mode A 1: Enable Dispense Mode A Only configure if in Constant Flow Mode
00080	79	R/W	1 BIT	0: Disable Dispense Mode B 1: Enable Dispense Mode B Only configure if in Constant Flow Mode
00081	80	R/W	1 BIT	0: Disable Dispense Mode C 1: Enable Dispense Mode C Only configure if in Constant Flow Mode
00082	81	R/W	1 BIT	0: Disable Dispense Mode D 1: Enable Dispense Mode D Only configure if in Constant Flow Mode
00083	82	R/W	1 BIT	1: Reset total volume delivered by multi-pump pair AB
00084	83	R/W	1 BIT	1: Reset total volume delivered by multi-pump pair CD
00085	84	R/W	1 BIT	1: Pressure Units =ATM
00086	85	R/W	1 BIT	1: Pressure Units = BAR
00087	86	R/W	1 BIT	1: Pressure Units = kPa
00088	87	R/W	1 BIT	1: Pressure Units = PSI
00089	88	R/W	1 BIT	1: Flow Units = ml/min
00090	89	R/W	1 BIT	1: Flow Units = ml/hr
00091	90	R/W	1 BIT	1: Flow Units = ul/min
00092	91	R/W	1 BIT	1: Flow Units = ul/hr
00093	92	R/W	1 BIT	0: Overpressure Alarm OFF 1: Overpressure Alarm ON
00094	93	R/W	1 BIT	0: Overpressure Display OFF 1: Overpressure Display ON
00095	94	R/W	1 BIT	0: Overpressure Shutdown OFF 1: Overpressure Shutdown ON
00096	95	R/W	1 BIT	0: Underpressure Alarm OFF 1: Underpressure Alarm ON
00097	96	R/W	1 BIT	0: Underpressure Display OFF 1: Underpressure Display ON
00098	97	R/W	1 BIT	0: Underpressure Shutdown OFF 1: Underpressure Shutdown ON
00099	98	R/W	1 BIT	0: Overflow Alarm OFF 1: Overflow Alarm ON
00100	99	R/W	1 BIT	0: Overflow Display OFF 1: Overflow Display ON
00101	100	R/W	1 BIT	0: Overflow Shutdown OFF 1: Overflow Display ON

Table 6-5 Coils (Continued)

Register	Address	Type	Size	Description
00102	101	R/W	1 BIT	0: Underflow Alarm OFF 1: Underflow Alarm ON
00103	102	R/W	1 BIT	0: Underflow Display OFF 1: Underflow Display ON
00104	103	R/W	1 BIT	0: Underflow Shutdown OFF 1: Underflow Shutdown ON
00105	103	R/W	1 BIT	0: Poor Fill Alarm A OFF 1: Poor Fill Alarm A ON
00106	105	R/W	1 BIT	0: Poor Fill Alarm B OFF 1: Poor Fill Alarm B ON
00107	106	R/W	1 BIT	0: Poor Fill Alarm C OFF 1: Poor Fill Alarm C ON
00108	107	R/W	1 BIT	0: Poor Fill Alarm D OFF 1: Poor Fill Alarm D ON
00109	108	R/W	1 BIT	1: Stop all motor and reset flow rate and pressure set-points to default.
00110	109	R	1 BIT	0: Transducer of Pump A not connected 1: Transducer of Pump A connected
00111	110	R	1 BIT	0: Pump A not at upper flag limit 1: Pump A at upper Flag Limit (Empty)
00112	111	R	1 BIT	0: Pump A not at lower flag limit 1: Pump A at lower flag limit (Full)
00113	112	R	1 BIT	1: Pump A is overpressure
00114	113	R	1 BIT	1: Pump A is underpressure
00115	114	R	1 BIT	1: Motor failure Pump A
00116	115	R	1 BIT	0: Transducer of Pump B not connected 1: Transducer of Pump B connected
00117	116	R	1 BIT	0: Pump B not at upper flag limit 1: Pump B at upper Flag Limit (Empty)
00118	117	R	1 BIT	0: Pump B not at lower flag limit 1: Pump B at lower flag limit (Full)
00119	118	R	1 BIT	1: Pump B is overpressure
00120	119	R	1 BIT	1: Pump B is underpressure
00121	120	R	1 BIT	1: Motor failure Pump B
00122	121	R	1 BIT	0: Transducer of Pump C not connected 1: Transducer of Pump C connected
00123	122	R	1 BIT	0: Pump C not at upper flag limit 1: Pump C at upper Flag Limit (Empty)
00124	123	R	1 BIT	0: Pump C not at lower flag limit 1: Pump C at lower flag limit (Full)
00125	124	R	1 BIT	1: Pump C is overpressure
00126	125	R	1 BIT	1: Pump C is underpressure
00127	126	R	1 BIT	1: Motor failure Pump C
00128	127	R	1 BIT	0: Transducer of Pump D not connected 1: Transducer of Pump D connected
00129	128	R	1 BIT	0: Pump D not at upper flag limit 1: Pump D at upper Flag Limit (Empty)
00130	129	R	1 BIT	0: Pump D not at lower flag limit 1: Pump D at lower flag limit (Full)
00131	130	R	1 BIT	1: Pump D is overpressure
00132	131	R	1 BIT	1: Pump D is underpressure
00133	132	R	1 BIT	1: Motor failure Pump D
00134	133	R	1 BIT	1: POOR FILL A ERROR
00135	134	R	1 BIT	1: POOR FILL B ERROR
00136	135	R	1 BIT	1: POOR FILL C ERROR
00137	136	R	1 BIT	1: POOR FILL D ERROR
00138	137	R	1 BIT	1: VALVE ERROR
00139	138	R	1 BIT	DIGITAL IN 1
00140	139	R	1 BIT	DIGITAL IN 2
00141	140	R	1 BIT	DIGITAL IN 3

Table 6-5 Coils (Continued)

Register	Address	Type	Size	Description
00142	141	R	1 BIT	DIGITAL IN 4

Table 6-6 Holding Registers

Register	Address	Read/ Write	Type	# of Registers	Description	Units
40001	0	R/W	FLOAT	2	Pressure set-point for Pump A in Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40003	2	R/W	FLOAT	2	Pressure set-point for Pump B in Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40005	4	R/W	FLOAT	2	Pressure set-point for Pump C in Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40007	6	R/W	FLOAT	2	Pressure set-point for Pump D in Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40009	8	R/W	FLOAT	2	Pressure set-point for multi-pump pair AB in Continuous Flow Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40011	10	R/W	FLOAT	2	Pressure set-point for multi-pump pair CD in Continuous Flow Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40013	12	R/W	FLOAT	2	Flow rate set-point for Pump A in Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40015	14	R/W	FLOAT	2	Flow rate set-point for Pump B in Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40017	16	R/W	FLOAT	2	Flow rate set-point for Pump C in Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40019	18	R/W	FLOAT	2	Flow rate set-point for Pump D in Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40021	20	R/W	FLOAT	2	Flow rate set-point for multi-pump pair AB in Continuous Flow Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40023	22	R/W	FLOAT	2	Flow rate set-point for multi-pump pair CD in Continuous Flow Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40025	24	R/W	FLOAT	2	Refill flow rate for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40027	26	R/W	FLOAT	2	Refill flow rate for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40029	28	R/W	FLOAT	2	Refill flow rate for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40031	30	R/W	FLOAT	2	Refill flow rate for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40033	32	R/W	FLOAT	2	Maximum pressure set-point for Pump A.	ATM; BAR; kPa; PSI See NOTE 1.
40035	34	R/W	FLOAT	2	Maximum pressure set-point for Pump B.	ATM; BAR; kPa; PSI See NOTE 1.
40037	36	R/W	FLOAT	2	Maximum pressure set-point for Pump C.	ATM; BAR; kPa; PSI See NOTE 1.
40039	38	R/W	FLOAT	2	Maximum pressure set-point for Pump D.	ATM; BAR; kPa; PSI See NOTE 1.
40041	40	R/W	FLOAT	2	Minimum pressure set-point for Pump A.	ATM; BAR; kPa; PSI See NOTE 1.
40043	42	R/W	FLOAT	2	Minimum pressure set-point for Pump B.	ATM; BAR; kPa; PSI See NOTE 1.
40045	44	R/W	FLOAT	2	Minimum pressure set-point for Pump C.	ATM; BAR; kPa; PSI See NOTE 1.
40047	46	R/W	FLOAT	2	Minimum pressure set-point for Pump D.	ATM; BAR; kPa; PSI See NOTE 1.
40049	48	R/W	FLOAT	2	Maximum flow rate set-point for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.

Table 6-6 Holding Registers (Continued)						
Register	**Address**	**Read/ Write**	**Type**	**# of Registers**	**Description**	**Units**
40051	50	R/W	FLOAT	2	Maximum flow rate set-point for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40053	52	R/W	FLOAT	2	Maximum flow rate set-point for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40055	54	R/W	FLOAT	2	Maximum flow rate set-point for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40057	56	R/W	FLOAT	2	Minimum flow rate set-point for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40059	58	R/W	FLOAT	2	Minimum flow rate set-point for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40061	60	R/W	FLOAT	2	Minimum flow rate set-point for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40063	62	R/W	FLOAT	2	Minimum flow rate set-point for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40065	64	R/W	FLOAT	2	Maximum flow limit in Constant Pressure mode for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40067	66	R/W	FLOAT	2	Maximum flow limit in Constant Pressure mode for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40069	68	R/W	FLOAT	2	Maximum flow limit in Constant Pressure mode for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40071	70	R/W	FLOAT	2	Maximum flow limit in Constant Pressure mode for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40073	72	R	FLOAT	2	Actual pressure of Pump A.	ATM; BAR; kPa; PSI See NOTE 1.
40075	74	R	FLOAT	2	Actual flow rate of Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40077	76	R	FLOAT	2	Volume remaining in Pump A.	milliliters
40079	78	R	FLOAT	2	Actual pressure of Pump B.	ATM; BAR; kPa; PSI See NOTE 1.
40081	80	R	FLOAT	2	Actual flow rate of Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40083	82	R	FLOAT	2	Volume remaining in Pump B.	milliliters
40085	84	R	FLOAT	2	Actual pressure of Pump C.	ATM; BAR; kPa; PSI See NOTE 1.
40087	86	R	FLOAT	2	Actual flow rate of Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40089	88	R	FLOAT	2	Volume remaining in Pump C.	milliliters
40091	90	R	FLOAT	2	Actual pressure of Pump D.	ATM; BAR; kPa; PSI See NOTE 1.
40093	92	R	FLOAT	2	Actual flow rate of Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40095	94	R	FLOAT	2	Volume remaining in Pump D.	milliliters
40097	96	R	FLOAT	2	System flow rate of multi-pump pair AB.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40099	98	R	FLOAT	2	System pressure of multi-pump pair AB.	ATM; BAR; kPa; PSI See NOTE 1.
40101	100	R	FLOAT	2	Total volume delivered by multi-pump pair AB.	Liters
40103	102	R	FLOAT	2	System flow rate of multi-pump pair CD.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40105	104	R	FLOAT	2	System pressure of multi-pump pair CD.	ATM; BAR; kPa; PSI See NOTE 1.
40107	106	R	FLOAT	2	Total volume delivered by multi-pump pair CD.	Liters
40109	108	R	FLOAT	2	Analog voltage input on Analog Input 1 of the accessory connector.	Volts
40111	110	R	FLOAT	2	Analog voltage input on Analog Input 2 of the accessory connector.	Volts
40113	112	R	FLOAT	2	Analog voltage input on Analog Input 3 of the accessory connector.	Volts

Table 6-6 Holding Registers (Continued)						
Register	**Address**	**Read/ Write**	**Type**	**# of Registers**	**Description**	**Units**
40115	114	R	FLOAT	2	Analog voltage input on Analog Input 4 of the accessory connector.	Volts
40117	116	R/W	FLOAT	2	Volume at which Pump A will automatically switch to refill mode if AUTO REFILL A is ON.	milliliters
40119	118	R/W	FLOAT	2	Volume at which Pump B will automatically switch to refill mode if AUTO REFILL B is ON.	milliliters
40121	120	R/W	FLOAT	2	Volume at which Pump C will automatically switch to refill mode if AUTO REFILL C is ON .	milliliters
40123	122	R/W	FLOAT	2	Volume at which Pump D will automatically switch to refill mode if AUTO REFILL D is ON.	milliliters
40125	124	R/W	FLOAT	2	Volume that Pump A will be refill to if AUTO FILL TO A is ON.	milliliters
40127	126	R/W	FLOAT	2	Volume that Pump B will be refill to if AUTO FILL TO B is ON.	milliliters
40129	128	R/W	FLOAT	2	Volume that Pump C will be refill to if AUTO FILL TO C is ON.	milliliters
40131	130	R/W	FLOAT	2	Volume that Pump D will be refill to if AUTO FILL TO D is ON.	milliliters
40133	132	R/W	FLOAT	2	Percentage of total pump volume that the refilling pump of multi-pump pair AB will refill to.	%
40135	134	R/W	FLOAT	2	Percentage of total pump volume that the delivering pump of multi-pump pair AB will deliver to.	%
40137	136	R/W	FLOAT	2	Percentage of total pump volume that the refilling pump of multi-pump pair CD will refill to.	%
40139	138	R/W	FLOAT	2	Percentage of total pump volume that the delivering pump of multi-pump pair CD will deliver to.	%
40141	140	R/W	FLOAT	2	POOR FILL MARK A	% VALID ENTRYS:10,20,30,40,50,60,70,80,90
40143	142	R/W	FLOAT	2	POOR FILL MARK B	% VALID ENTRYS:10,20,30,40,50,60,70,80,90
40145	144	R/W	FLOAT	2	POOR FILL MARK C	% VALID ENTRYS:10,20,30,40,50,60,70,80,90
40147	146	R/W	FLOAT	2	POOR FILL MARK D	% VALID ENTRYS:10,20,30,40,50,60,70,80,90
40149	148	R/W	FLOAT	2	Volume being dispensed by Pump A in Dispense mode.	milliliters
40151	150	R/W	FLOAT	2	Volume being dispensed by Pump B in Dispense mode.	milliliters
40153	152	R/W	FLOAT	2	Volume being dispensed by Pump C in Dispense mode.	milliliters
40155	154	R/W	FLOAT	2	Volume being dispensed by Pump D in Dispense mode.	milliliters

Table 6-6 Holding Registers (Continued)						
Register	**Address**	**Read/ Write**	**Type**	**# of Registers**	**Description**	**Units**
40157	156	R/W	FLOAT	2	Full scale input range voltage for External mode.	Volts
40159	168	R/W	FLOAT	2	MIN MOD PRESS: Minimum modifier pump pressure	ATM; BAR; kPa; PSI See NOTE 1.
40161	160	R/W	FLOAT	2	Value of %B for Modifier addition mode.%C for Continuous Modifier addition mode.	%B FOR MODIFIER OR %C FOR CONTIN-UOUS MODIFIER
40201	200	R	FLOAT	2	Absolute maximum pressure for Pump A.	ATM; BAR; kPa; PSI See NOTE 1.
40203	202	R	FLOAT	2	Absolute maximum flow rate for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40205	204	R	FLOAT	2	Absolute maximum refill rate for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40207	206	R	FLOAT	2	Maximum volume for Pump A.	milliliters
40209	208	R	FLOAT	2	Absolute maximum pressure for Pump B.	ATM; BAR; kPa; PSI See NOTE 1.
40211	210	R	FLOAT	2	Absolute maximum flow rate for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40213	212	R	FLOAT	2	Absolute maximum refill rate for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40215	214	R	FLOAT	2	Maximum volume for Pump B.	milliliters
40217	216	R	FLOAT	2	Absolute maximum pressure for Pump C.	ATM; BAR; kPa; PSI See NOTE 1.
40219	218	R	FLOAT	2	Absolute maximum flow rate for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40221	220	R	FLOAT	2	Absolute maximum refill rate for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40223	222	R	FLOAT	2	Maximum volume for Pump C.	milliliters
40225	224	R	FLOAT	2	Absolute maximum pressure for Pump D.	ATM; BAR; kPa; PSI See NOTE 1.
40227	226	R	FLOAT	2	Absolute maximum flow rate for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40229	228	R	FLOAT	2	Absolute maximum refill rate for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40231	230	R	FLOAT	2	Maximum volume for Pump D.	milliliters
40233	232	R	FLOAT	2	PUMP TYPE A	
40235	234	R	FLOAT	2	PUMP TYPE B	
40237	236	R	FLOAT	2	PUMP TYPE C	
40239	238	R	FLOAT	2	PUMP TYPE D	
40241	240	R	FLOAT	2	SOFTWARE MAJOR REV	
40243	242	R	FLOAT	2	SOFTWARE MINOR REV	
40245	244	R	FLOAT	2	SOFTWARE MICRO REV	

☑ *Note*

Pressure and flow rate based on user selected units.

HL_f Series Syringe Pumps

Section 7 Serial Interface

7.1 Overview

The Teledyne ISCO HL_f Series pump can be remotely controlled by a computer through a built-in RS-232-C serial or USB interface. This function is supported by the Teledyne ISCO LabView™ toolkit.

You can write your own custom program to control ISCO syringe pumps using any format, such as BASIC or C++. This section provides the syntax and responses for serial commands. Simplified examples of programs are also provided. It is possible for you to write custom programs capable of controlling up to 7 controllers from a single computer, each with up to 4 connected pumps. Writing programs for serial control requires substantial knowledge of the software language used, so ISCO does not provide support for developing your own programs.

The toolkit is a sample program capable of running one controller and one to three pumps. Its primary purpose is to provide an example to help the programmer start constructing custom programs for individual pump systems and applications. To modify the program in any way, you must have the complete **LabView Compiler**, available from LabView's manufacturer:

National Instruments Corporation
www.ni.com
Tel: (800) 531-5066
Fax: 512-683-8411
11500 N. Mopac Expwy
Austin, TX 78759-3504

This section of the manual provides detailed information about:

Cable Connections for Serial Control

Setting up the Controller(s) for Serial Control

DASNET Protocol

Serial Commands

7.2 Network Control and Communication

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). It is also important that each unit's baud rate is set to the same speed. Possible baud rates are **1200** and **19200**. Other baud rates of 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 are supported by the HL_f Series pumps but are not part of the Teledyne ISCO defined communications standard.

Electrical standards are RS-232-C; connector pin usage is outlined in Table 7-1. Characters consist of 1 start bit, 8 data bits (low order first with 8^{th} 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).

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.

⚠ 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 7-1 RS-232 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 pin 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, & 7 are required for serial interface to one controller.		

7.3 USB Interface

The ISCO HL_f Series syringe pump controller includes a USB interface. The USB connections are located on the pump controller rear panel labeled USB/Ethernet. The connector pin usage is outlined in Table 7-2. The drivers for the USB can be downloaded from http://www.isco.com/support/updates.asp

⚠ 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 7-2 USB Interface Pin Connections (on the USB/Ethernet connector)

Pin Number	Name
7	GND
11	Data -
12	Data +

7.4 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_f 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 to your network will depend on the type of serial port your computer has and the number of controllers you wish to connect.

Network communications are initiated by your computer.

7.4.1 One Controller

To connect one controller, use a null-modem cable (available from Teledyne ISCO, part #480-7996-00) to connect the 9-pin serial output port of the computer to the RS-232-C port on the rear of the controller, as shown in Figure 7-1.

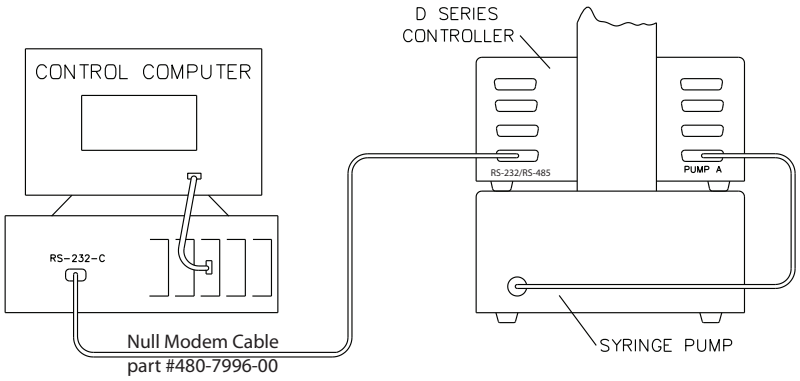


Figure 7-1 Serial network connection example - Single connection

With this configuration, your sample program is capable of:

- Constant flow
- Constant pressure
- Gradient

7.4.2 Two Controllers (Compiler required)

To connect two controllers in the network, use the 'Y' cable #68-1020-198, as shown in Figure 7-2.

> **☑ 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.

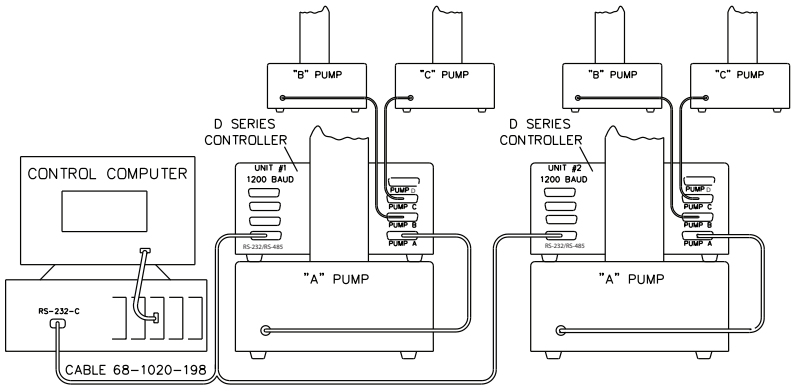


Figure 7-2 Serial network connection example - Dual connection

7.4.3 Three or More Controllers (Compiler required)

If additional instruments are to be connected in series, use the daisy chain cable, #68-1020-180. This cable is attached to the remaining connector on the 'Y' cable (Figure 7-2), and then to the RS-232-C connectors on the rear panels of the additional controllers.

7.5 Serial Control Check List

In order to build and operate a custom program for ISCO syringe pumps, you must have the following:

1. Sample program (ISCO LabView toolkit)*
2. LabView Compiler (purchased separately)
3. Connection cable(s)
4. 1 controller: cable 480-7996-00
5. 2 controllers: cable 68-1020-198
6. 3 to 7 controllers: cables 68-1020-198 and 68-1020-180.
7. Source code (serial commands in computer language for DASNET conversion)
8. DASNET serial driver

*The toolkit comes with directories for two different versions of LabView. Copy the .zip files onto your computer.

The files within each directory are as follows:

\labview8.5	**\labview5-8.2**
CONTROL.LLB	CONTROL.LLB
DASNET.DLL	DASNET.DLL
DATA.LLB	DATA.LLB
ISCO1.LLB	ISCO1.LLB
ISCO2.LLB	ISCO2.LLB
ISCO3.LLB	ISCO3.LLB
MULTPUMP.LLB	MULTPUMP.LLB
PANEL.VI	PANEL.VI
README.DOC	README.DOC
SERIALIO.LLB	SERIALIO.LLB

7.6 Controller Setup

Once the system is properly connected, turn the pump, controller(s), and computer on. Then use the following procedure to place your controller(s) in serial control mode.

Press MENU > MORE (A) and select SERIAL (1).
Factory controller default settings are baud rate 9600 and unit ID #6.

7.6.1 Restore Defaults (if desired)

To restore defaults, press MENU, then SYSTEM RESET (5). **Resetting a system erases all programs and user settings.**

7.6.2 Change Defaults

1. Press MENU > MORE (A) > 1. Serial Option to enter the serial option setup screen.
2. Select the communication baud rate (between 300 and 115.2K) by pressing NEXT BAUD (A) until you reach the desired baud rate.

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

3. Select an identification number for each controller (up to seven) by pressing NEXT ID # (B) until you reach the desired number.

> ☑ ***Note***
>
> Multiple controllers in a network must each have a different ID number.

If several units are being configured, place a label on the rear of each instrument listing the ID number and baud rate. This will help identify the controller in the future and prevent assigning the same ID number to two controllers or assigning an incorrect baud rate.

7.6.3 Verify Operation

To verify network operation, open a terminal emulator program on your computer, such as HyperTerminal, and establish connection with the controller.

> ☑ ***Note***
>
> If you will be using multiple controllers daisy-chained to a single serial port, you must connect and test each controller one at a time.

1. Press MENU > MORE (A) > MORE (A), and select DIAGNOSTIC MENU (2).
2. Select SERIAL TEST (6).

The SENT value displayed will increment indefinitely until you exit the test by pressing any key. This same value should appear on your computer screen. If it does not, verify that you are using the correct serial port on the computer, and that the communication cables are properly connected and in working order.

7.7 User-written Software

When designing software to control the HL_f 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_f 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 7-1 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.

7.7.1 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 7-3 is an example BASIC language program which performs the required portion of the DASNET serial protocol. Table 7-4 is an example of a C language program which does the same. Both of these programs, including a DASNET serial driver written in Visual C++, are available on CD-ROM (P/N 60-1245-096) in the sleeve at the back of the printed manual.

7.7.2 Universal Driver from Teledyne ISCO

The Universal Driver from Teledyne ISCO is a serial software driver that can translate commands for a variety of compilers. When you are creating programs for HL_f Series syringe pumps, the driver converts serial commands to DASNET communications protocol, sends them to the serial port, and waits for a serial response.

> ☑ ***Note***
>
> On our website:
> Detailed information about the Universal Driver is provided in ISCO Technical Bulletin TB19 Universal Driver Software Tool.
> LabView operation is discussed in detail in ISCO Technical Bulletin TB06 Basic Operation of LabView Toolkit.

A copy of the driver can be found on the CD included in the back of your HL_f Series pump user manual. It can also be downloaded from:

http://www.isco.com/products/appnotes.asp?PL=105.

Open the Software Utilities folder and select Universal D-Series Pump driver to download the utility to a zip folder. Extract the sub folder named "Remote Pump."

Table 7-3 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. QBasic is an integrated BASIC language interpreter created by Microsoft Corp, Redmond, WA, included in MSDOS version 5.0 and later, and in Windows 95, 98, NT 3.x and NT4.

Table 7-4 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 TurboC, version 4.5. TurboC is a compiler created by Borland Software Corp., Austin, TX. It is no longer actively sold by Borland International.

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_f 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 260D pump. Details on the pump message format are in section 7.8. 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 ___D. 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 ___D PUMP, REV __XX[CR]
The pump responds with identity and software revision letter. (In this example 02__ would be 021; Model ___D would be 260D; 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 7.8 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_f Series controller is limited to single commands. It will respond with a PROBLEM=INVALID COMMAND message.

7.8 Serial Commands for the HL_f Series Pump

Table 7-5 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 7-5 Serial Commands

Command	Description
%B=#	Enter # for percentage of modifier.
ALOG1	Status of the analog voltage input on pin 21, P6. See NOTE 1.
ALOG2	Status of the analog voltage input on analog input 3 of the accessory connector. See NOTE 1.
ALOG3	Status of the analog voltage input on analog input 2 of the accessory connector. See NOTE 1.
ALOG4	Status of the analog voltage on analog input 1 of the accessory connector. See NOTE 1.
ALOG5	Status of the analog voltage input for Press D. See NOTE 1.
ALOG6	Status of the analog voltage on analog input 4 of the accessory connector. See NOTE 1.
CLEAR	Stops all motors, sets flow rate and pressure setpoints to zero.
CONTIN CONST FLOW CONTIN CONST FLOWCD	Puts pump in continuous flow under constant flow mode.
CONTIN CONST PRESS CONTIN CONST PRESSCD	Puts pump in continuous flow under constant pressure mode.
CONTIN MODIFIER	Put pump in continuous modifier addition mode.
CONST FLOW CONST FLOWB CONST FLOWC CONST FLOWD	Put pump in constant flow mode.
CONST PRESS CONST PRESSB CONST PRESSC CONST PRESSD	Put pump in constant pressure mode.
DELIVER DELIVERCD	Set the dual pump mode to deliver fluid when running.
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. “X”= no change.
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.

Table 7-5 Serial Commands (Continued)

Command	Description
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 = command 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.
DISPENSEA DISPENSEB DISPENSEC DISPENSED	Returns the dispense volume for Dispense mode.
DISPENSEA=# DISPENSEB=# DISPENSEC=# DISPENSED=#	Sets the dispense volume for Dispense mode. Format is XXX.XXX ml. Leading and trailing zeros are not required. Can only be changed when pump is stopped.
FLOW FLOWCD	Returns the delivering pump's flow rate in continuous pumping mode and modifier addition mode. In INDEPENDENT mode FLOW returns the pump A flow rate and FLOWCD returns the pump C flow rate.
FLOWA FLOWB FLOWC FLOWD	Returns the actual flow rate of the pump.
FLOW=# FLOWB=# FLOWC=# FLOWD=#	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.
G GG G& G&2	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. For four pump operation use the G&2 commands. Refer to 7.8.1 for a complete description of this serial command.
IDENTIFY	Pump responds "SERIES=1240-0___, MODEL ____D PUMP; REV__." For each pump, REV__ is the internal pump program software revision. (For example, if the controller was attached to two 100DMs, the message would read "SERIES=1240-024, MODEL 100DM PUMP; SERIES=1240-024, MODEL 100DM; 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=1260-008, MODEL 260HL PUMP SERIES=1260-009, MODEL 500HL PUMP SERIES=1260-007, MODEL 100HLX PUMP SERIES=1260-010, MODEL 1000HL PUMP SERIES=1260-015, MODEL 260HLf PUMP SERIES=1260-011, MODEL 500HLf PUMP SERIES=1260-014, MODEL 100HLf PUMP SERIES=1260-016, MODEL 1000HLf PUMP
INDEPENDENT INDEPENDENTCD	Put pumps in Independent mode.

Table 7-5 Serial Commands (Continued)

Command	Description
IPUMPA=1, IPUMPA=0 IPUMPB=1, IPUMPB=0 IPUMPC=1, IPUMPC=0 IPUMPD=1, IPUMPD=0	Turns the pressure integral control On and Off for the pump indicated. 1 = ON 0 = OFF
LGE,F:XX,A:0X	Action to perform when gradient program reaches the end. The pump needs to be in local mode only. File # F: 01-99 Action A: 00=Hold final value 01=Stop after final step 02=Return to initial value and hold 03=Return to initial value and repeat program
LGGO	Start Gradient Command. This starts a gradient program (same as the “RUN” key). This command will check to see if there is a gradient running and respond with “RUNNING” if there is. The pump needs to be in local mode only.
LGSL,F:xx	Select Gradient File Command. This selects a gradient file to be run. This command will reset the controller to the saved file gradient type. If the selected gradient file does not exist, the controller will respond with “PROBLEM=INVALID OPERAND.” The pump needs to be in local mode only.
LGST	Stop Gradient Command. This stops a gradient program. The pump needs to be in local mode only.
LGDL,F:xx,S:xx	Gradient Step Download command. This downloads a step from the pump to the PC. This command will respond with “PROBLEM=INVALID OPERAND” if the file or step does not exist. The controller will respond with step information if the command is valid. Refer to 7.8.2 for complete information on Gradient step download commands. The pump needs to be in local mode only.
LGUL,F:xx,S:xx	Gradient Step Upload command. This transfers a step from the PC to the controller. Refer to 7.8.3 for complete information on Gradient step download commands. The pump needs to be in local mode only.
LIMITS LIMITSB LIMITSC LIMITSD	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=# MAXFLOWD=#	Enter # to designate the maximum flow rate setpoint.
MAXFLOWA MAXFLOWB MAXFLOWC MAXFLOWD	Returns the maximum flow rate setpoint.
MAXPRESSA=# MAXPRESSB=# MAXPRESSC=# MAXPRESSD=#	Enter # to designate the maximum pressure setpoint.
MAXPRESSA MAXPRESSB MAXPRESSC MAXPRESSD	Returns the maximum pressure setpoint.

Table 7-5 Serial Commands (Continued)

Command	Description
MFLOWA=# MFLOWB=# MFLOWC=# MFLOWD=#	Enter # to designate the maximum flow limit in constant pressure mode.
MFLOWA MFLOWB MFLOWC MFLOWD	Returns the maximum flow limit setpoint.
MINFLOWA=# MINFLOWB=# MINFLOWC=# MINFLOWD=#	Enter # to designate the minimum flow rate setpoint.
MINFLOWA MINFLOWB MINFLOWC MINFLOWD	Returns the minimum flow rate setpoint.
MINPRESSA=# MINPRESSB=# MINPRESSC=# MINPRESSD=#	Returns the minimum pressure setpoint.
MINPRESSA MINPRESSB MINPRESSC MINPRESSD	Returns the minimum pressure setpoint.
MODE	MODE A P, B P, C P, D-P A, B, C, D refer to the pump connection. P- Constance Pressure F- Constant Flow R- Refill PG- Pressure Gradient F1- Flow Gradient 1 Pump F2- Concentrated Gradient 2 Pump CF- Continuous Constant Flow CP- Continuous Constant Pressure MO- Modifier Mode 2 Pump MM- Modifier Mode 3 Pump
MODIFIER	Put pumps in modifier addition mode.
PRESS=# PRESSB=# PRESSC=# PRESSD=#	Enter # to designate pressure setpoint (constant pressure mode).
PRESS PRESSCD	Returns the delivering pump pressure in continuous pumping mode and modifier addition mode. In INDEPENDENT mode PRESS returns the pump A pressure and PRESSCD returns the pump C pressure.
PRESSA PRESSB PRESSC PRESSD	Returns the actual pressure of the pump.
PRESSCNTRLDIFF1	Sets the pressure control input to Analog input 1, with a pressure range of 50 psi.

Table 7-5 Serial Commands (Continued)

Command	Description
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 “ALOGx” serial commands.
RANGEA RANGEB RANGEC RANGED	Provides scaling information for the system parameters. See 7.8.4 for more information about this serial command.
RAPIDA RAPIDB RAPIDC RAPIDD	Activates the automatic rapid pressurization cycle (constant flow mode only).
RECEIVE RECEIVECD	Set the dual pump mode to receive fluid when running.
REFILL REFILLB REFILLC REFILLD	Move cylinder to bottom at preset refill rate.
REFILL=# REFILLB=# REFILLC=# REFILLD=#	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 RLIMITD	Returns the refill flow rate limit.
RSVP RSVPB RSVPC RSVPD	Pump responds with “READY” message.
RUN RUNB RUNC RUND RUNALL	Same as front panel. Initiates pumping.
SETFLOWA SETFLOWB SETFLOWC SETFLOWD	Returns the flow rate setpoint.

Table 7-5 Serial Commands (Continued)

Command	Description
SETPRESSA SETPRESSB SETPRESSC SETPRESSD	Returns the pressure setpoint.
STATUSA STATUSB STATUSC STATUSD	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 STOPD STOPALL	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 VOLD	Return the volume remaining in cylinder in ml. Format is “XXX.XXXX” ml.
VOLTOT VOLTOTCD	Returns the total volume delivered when using continuous flow or modifier.
VOL RESET VOL RESETCD	Will reset the volume total to zero.
ZEROA ZEROB ZEROC ZEROD	“Zeros” the pressure sensor offset.
ZERODIFF1 ZERODIFF2 ZERODIFF3	“Zeros” the pressure sensor offset for the respective analog input.
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 or modifier addition mode are: %B, FLOWB, LIMITSB, PRESSB, REFILLB, REFILLB=, STATUSB, VOLB.	

7.8.1 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 7-3 and 7-5.

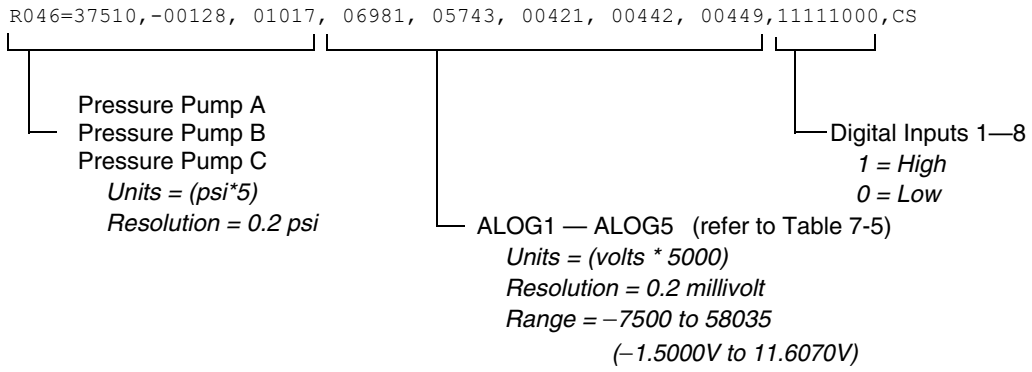


Figure 7-3 Get Status String "G" Command

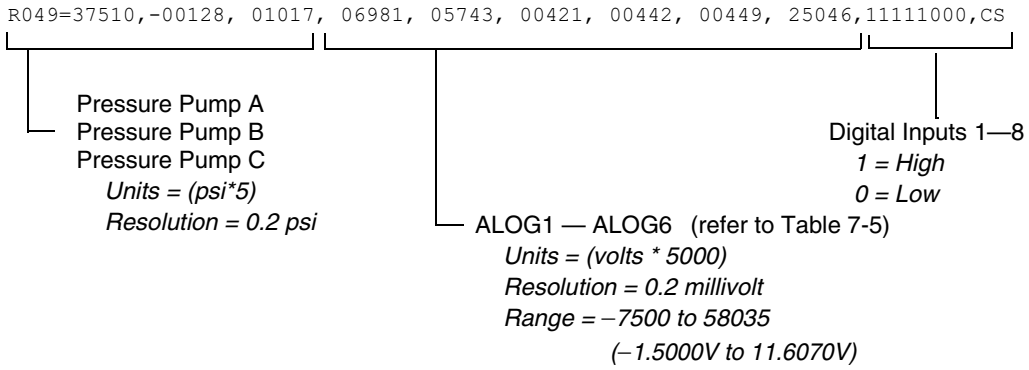


Figure 7-4 Get Status String "GG" Command

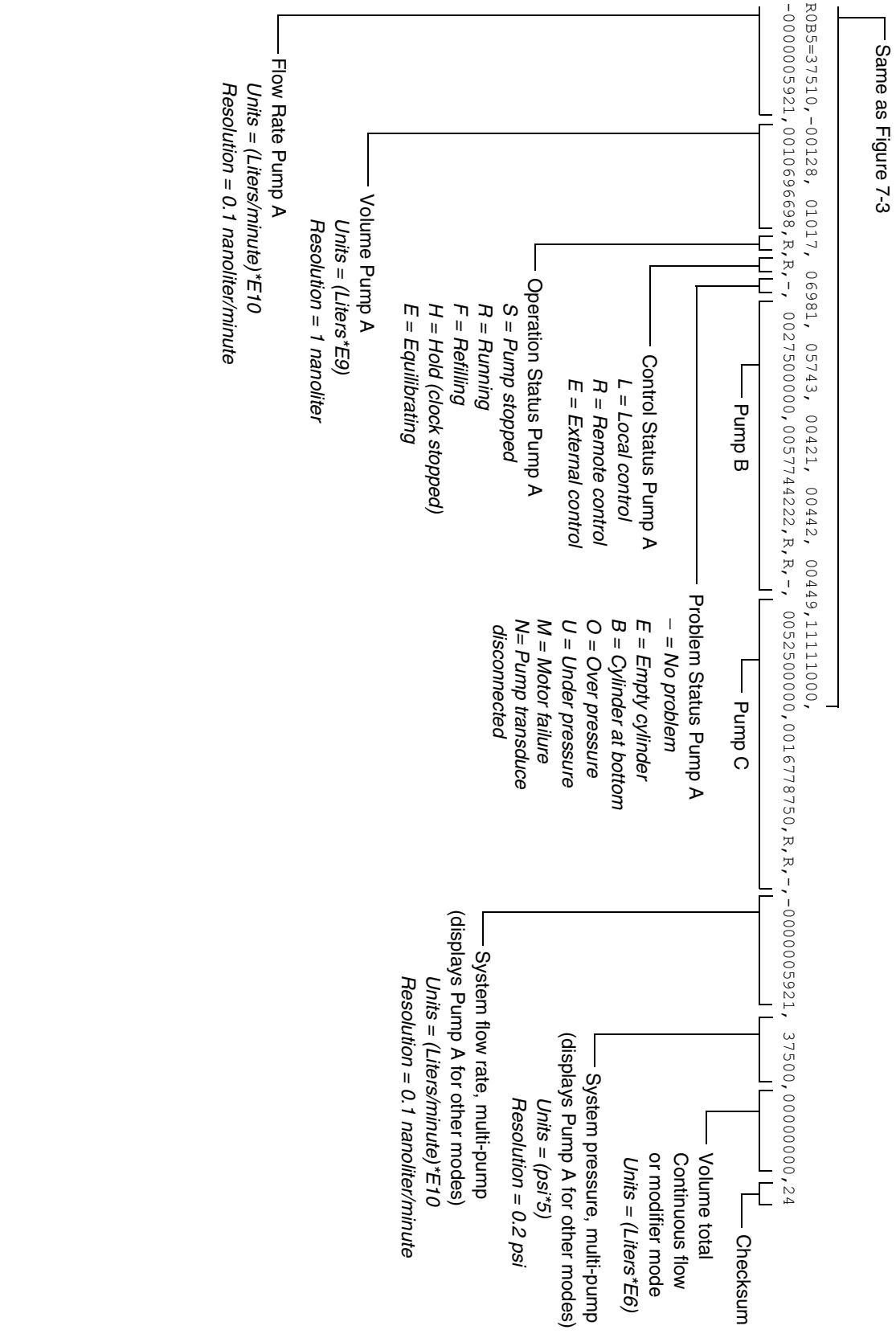


Figure 7-5 Get All Status String "G&" Command

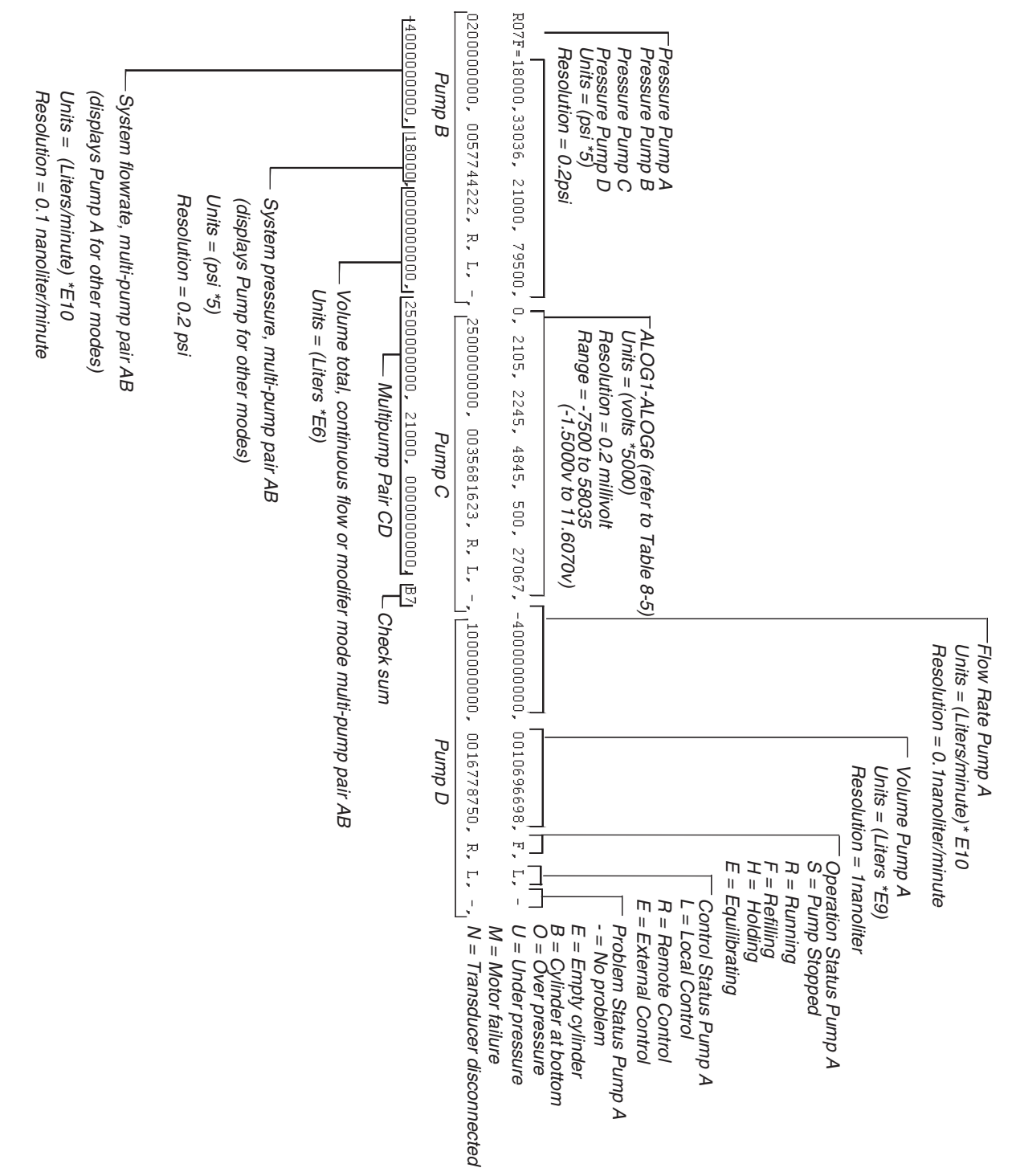


Figure 7-6 Get all status strings from four pump operation "G&2" Command

7.8.2 Gradient Download Command

This command downloads a step from the HL_f Series pump to the PC. This command will respond with "PROBLEM=INVALID COMMAND" if the file or step does not exist. If the file and step is valid, the controller will respond as shown in Figures 7-7 and 7-8.

7.8.3 Gradient Upload Commands

These commands upload a step from the PC to the HL_f Series pump. This command will respond with "PROBLEM=INVALID COMMAND" if the file or step does not exist. If the file and step is valid, the controller will respond as shown in Figures 7-9 and 7-10. Figure 7-11 shows an example of a pressure programming upload command.

☑ Note

Gradient upload commands must follow the format shown in the figures below. Where necessary, leading and trailing zeros must be included so that the numerical values are represented properly. Also note that the single-pump gradient commands include spaces in the command string.

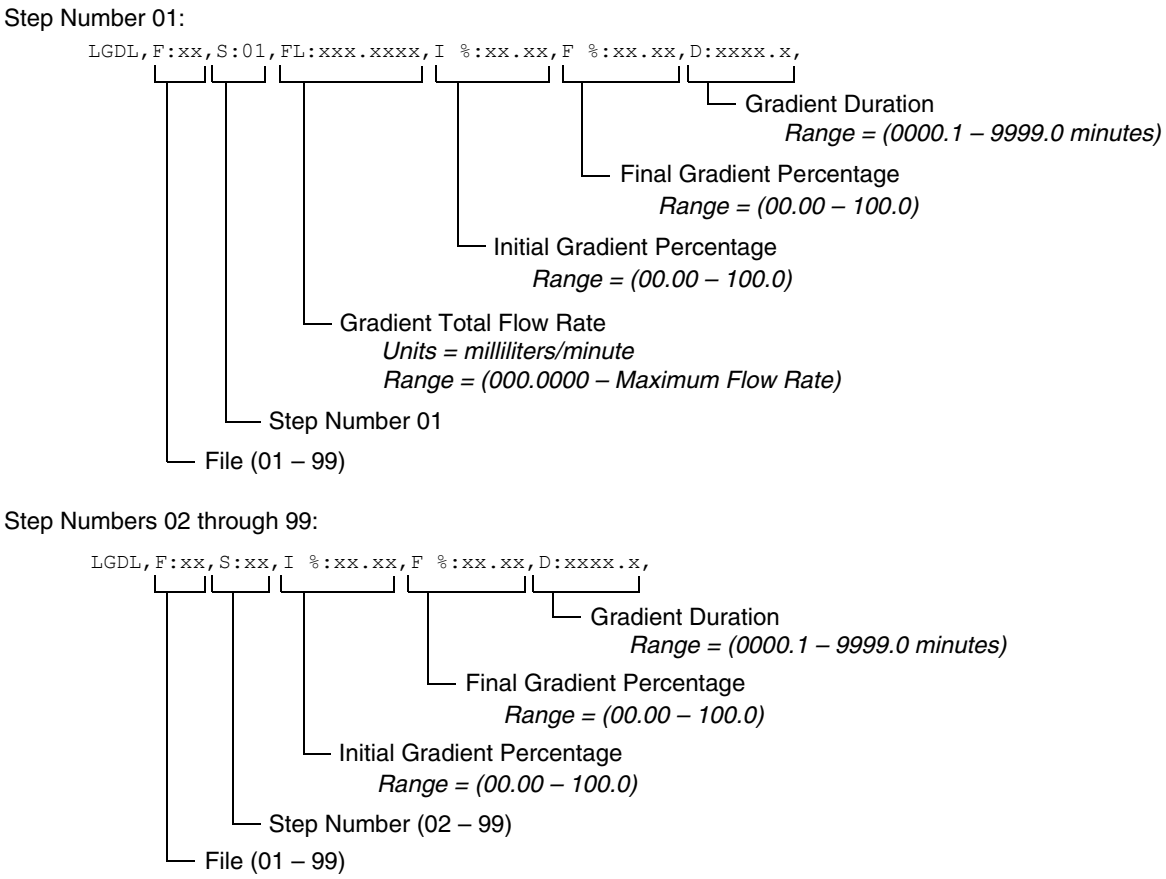


Figure 7-7 Gradient Download Commands - Single pump flow gradient

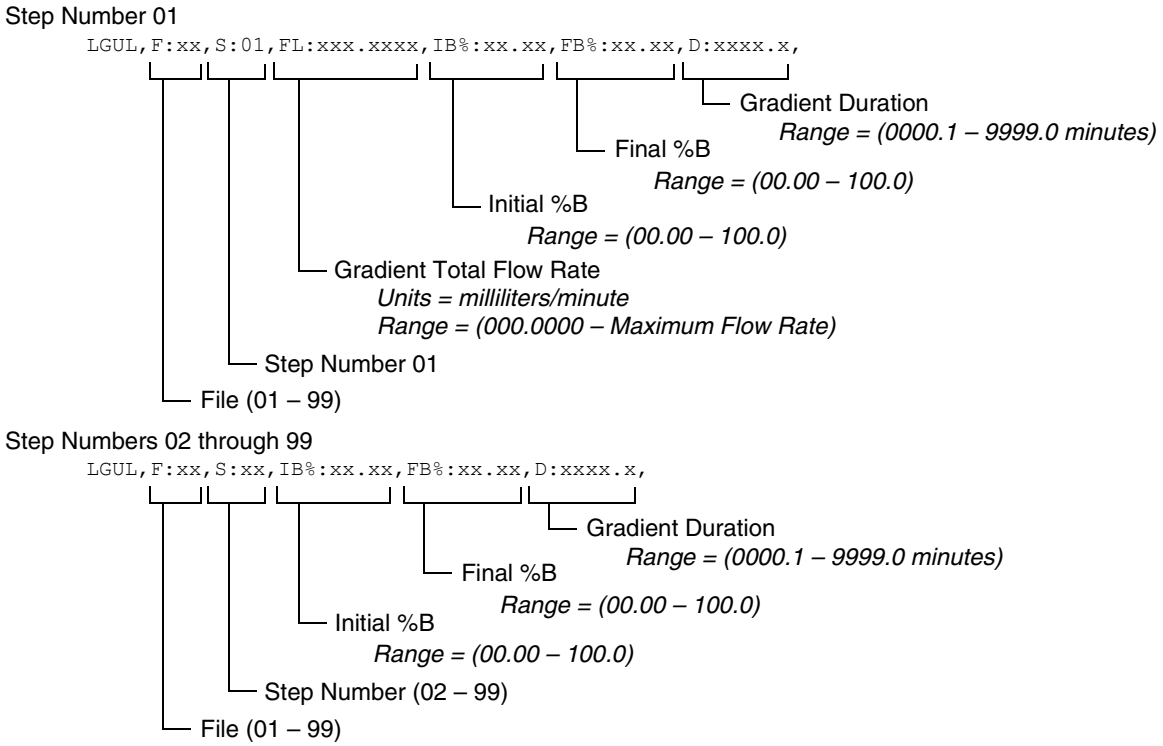
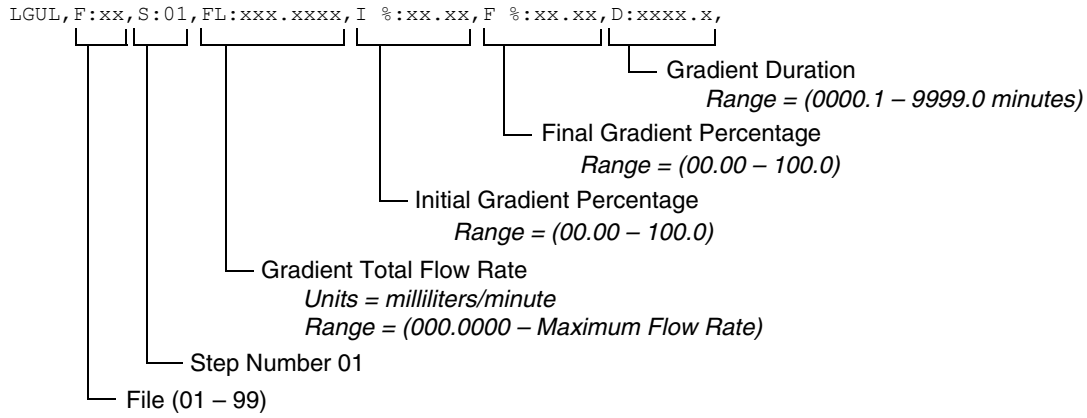


Figure 7-8 Gradient Download Commands - Two pump flow gradient

Step Number 01:



Step Numbers 02 through 99:

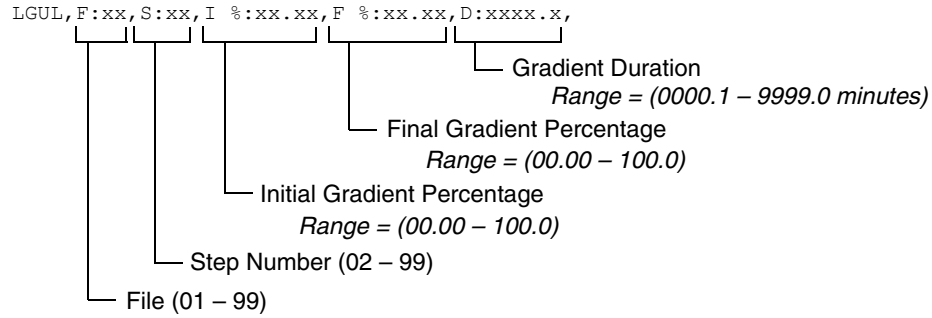


Figure 7-9 Gradient Upload Commands - Single pump flow gradient

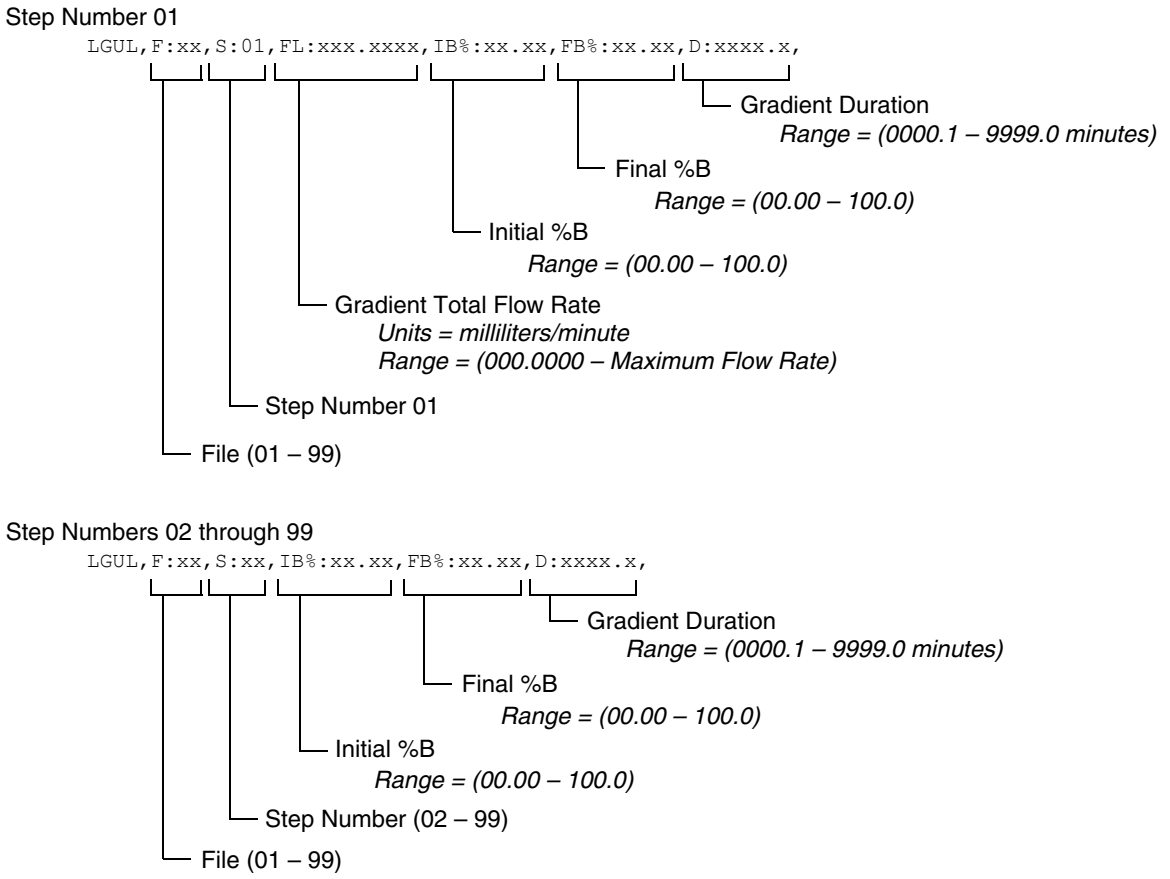


Figure 7-10 Gradient Upload Commands - Two pump flow gradient

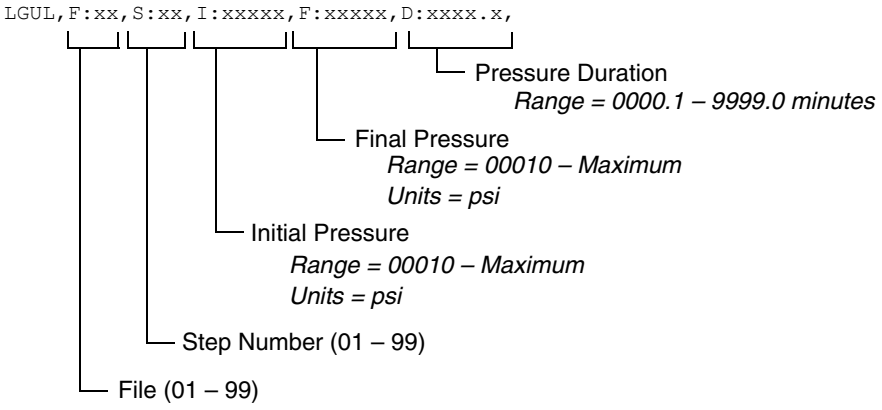


Figure 7-11 Upload Commands - Single pump pressure programming

7.8.4 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 7-12.

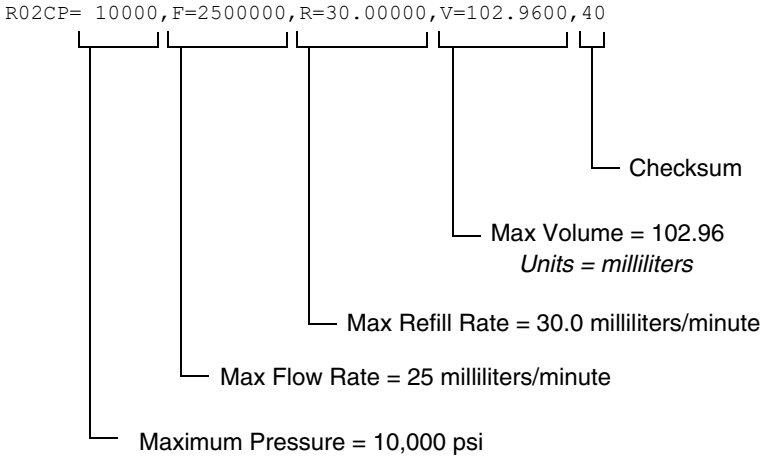


Figure 7-12 Range Serial Commands

7.8.5 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 7-6.

Table 7-6 Error Messages

Error	Description
PROBLEM=LOCAL MODE	The pump was sent a command before being placed in remote mode. See Section 7.8.
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.

HL_f Series Syringe Pumps

Section 8 Pump Maintenance, Troubleshooting, and Servicing

DANGER

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

DANGER

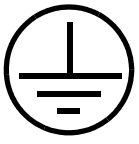
RISQUE DE CHOC ÉLECTRIQUE. COUPER L´ALIMENTATION AVANT LA RÉPARATION. L´USAGER NE DOIT PAS DÉMONTER L´INSTRUMENT OU DÉRANGER LE MÉCANISME DEDANS. ADRESSER LA REPARATION SEULEMENT AUX TECHNICIENS COMPÉTENTS.

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 locations 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.

8.1 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 schematic drawings referred to in this section, first find the serial number for your unit. Then go to our Web site at www.isco.com. In the left column, under Service & Support, click **Schematics**.

Enter your serial number in the field provided and click **Get Schematics**. If you need assistance, or don't see the correct schematic for your specific unit, contact our service department.

8.1.1 Service Department

If you have a question about a procedure, need parts information, or need some help, call or email the Teledyne ISCO Service department. In your message, be sure to include all the details about your instrument and the nature of the error.

Call the Service Department before returning the unit for factory repair. Often a problem can be solved in the field with just a little extra help.

Contact us at:

Toll free (800) 775-2965
Outside USA, Canada, and Mexico: (402) 464-0231
Email IscoService@teledyne.com

8.1.2 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 cost

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.

8.2 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.

8.3 Resetting the System

This action **completely deletes** user programmed settings, erasing all programs and returning the controller to factory default settings. Record your program settings and parameters before performing a reset operation. If ZERO PRESS has been pressed, all corrected offsets will be lost.

8.3.1 Basic Reset

To perform a **basic reset**, press MENU > SYSTEM RESET (5) > CONTINUE (A).

8.3.2 Hard Reset

To 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.

8.4 Diagnostic Menu

The syringe pump controller can run a number of system tests that are initialized using the keypad.

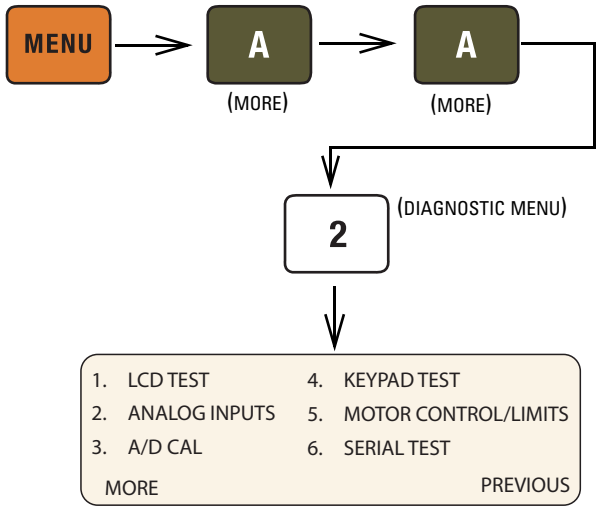


Figure 8-1 Accessing the diagnostic menu

8.4.1 LCD TEST

Cycles all segments of the display through all displayed characters. To stop the test, press any key.

8.4.2 ANALOG INPUTS

Displays the values of all analog inputs in volts. In the left column, with all connected pumps at zero pressure, the pressure readings should be near zero.

After the initial reading, pressurize the pump and then observe the test screen once more to verify that the value for that pump has increased.

The right column represents the four analog input terminals on the rear panel of the controller. For any terminal shorted to ground, the value should read a steady zero.

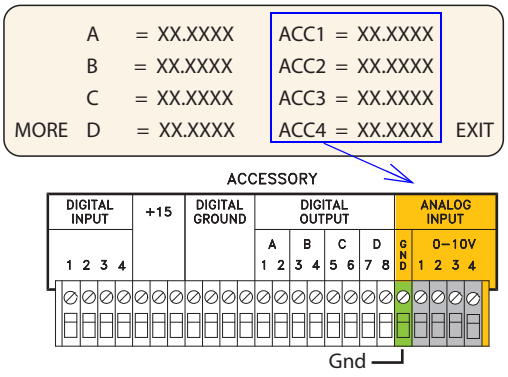


Figure 8-2 Analog Input diagnostic screen

Press EXIT (D) to return to the diagnostic menu.

8.4.3 KEYPAD TEST

The screen will briefly display the name of each key pressed. Press EXIT (D) to return to the diagnostic menu.

8.4.4 MOTOR CONTROL/LIMITS

Tests the digital position controls.

From the Limits menu, you can set minimum and maximum flow rate limits and pressure limits, as well as the maximum flow rate in constant pressure mode. High and low limits cannot exceed pump specifications.

The pump stays within these limits by means of a flag that moves up and down with the ball nut assembly, and two optical sensors at the top and bottom of the tower side plate.

When a sensor is interrupted, it has a logic 1; when it is uninterrupted, it has a logic 0. Therefore:

Top 0, Bottom 1 = Cylinder is full.

Top 1, Bottom 0 = Cylinder is empty.

Top 1, Bottom 1 = Illegal state.

An illegal state can indicate failure of one or both sensors. The controller display will toggle immediately between CYLINDER FULL and CYLINDER EMPTY when you press REFILL or RUN (the pump will not run).

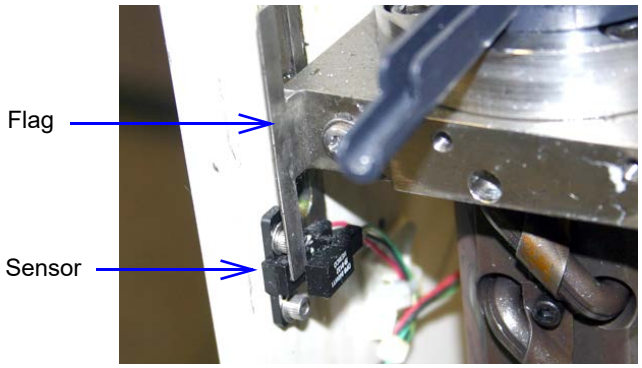
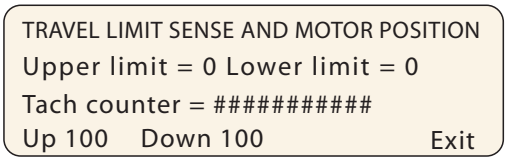


Figure 8-3 Optical sensor, interrupted by flag (bottom sensor shown, rear tower cover plate removed)

Select the pump to be tested (A, B, or C).



Press UP 100 (A) or DOWN 100 (B) to move the piston up or down 100 counts. The tach counter value will increase or decrease by 100 counts, accordingly. When the ball nut assembly reaches the top or bottom of the tower, the corresponding limit will change from 0 to 1. If the cylinder was refilled using the REFILL button,

it may require multiple presses of the 'UP 100' softkey before the 'Lower Limit' indicator changes to 0. When the Lower Limit indicator is 1, pressing the DOWN 100 softkey will have no effect.

If the rear tower cover plate is removed to expose the sensors, as shown above in Figure 8-3, you can simply interrupt the sensors with a slip of paper, rather than using the flag.

If either sensor fails, the sensor harness must be replaced.

Press EXIT (D) to return to the diagnostic menu.

8.4.5 SERIAL TEST

Tests the serial channel.

First, confirm operation of the **internal port**. On the RS-232-C port on the rear of the controller, short pins **2 and 3** and then run the test. The screen should display:

```
Rec: ****** Serial Test #### *****
Sent: ****** Serial Test #### *****

Press any key to exit
```

The four digits in the REC line should match the four digits in the SENT line, with a very slight delay.

If the unit passes the internal port test, next perform the **I/O** test. Use a null-modem cable (available from Teledyne ISCO, part #480-7996-00) to connect the 9-pin serial output port of a computer to the RS-232-C port, as shown on the following page.

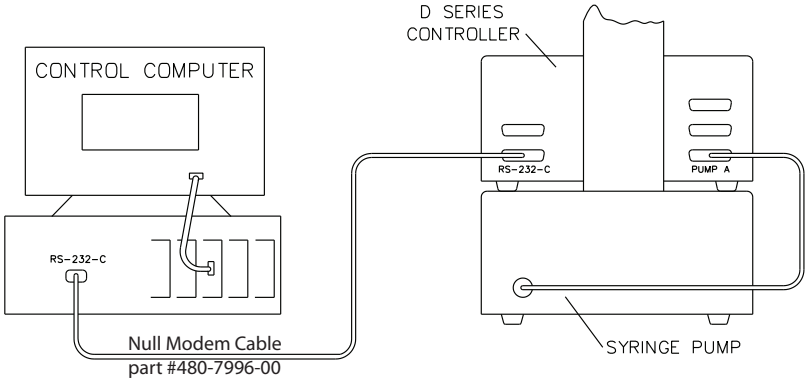


Figure 8-4 Serial connection to a computer

Open a terminal emulator program such as HyperTerminal (©Hilgraeve, Inc. Monroe, MI). The factory default port settings are:

BPS - 9600. Baud rate should match controller setting (refer to Section 7.2)

Data bits - 8

Parity - None

Stop bits - 1

Flow control - None

Run the test again. The screen should display:

```
Rec: [whatever is typed from PC]
Sent: ****** Serial Test #### *****

Press any key to exit
```

Anything typed on the computer keyboard should appear in the top line on the controller display. The computer should continually display the serial test shown in the second line of the controller display.

8.5 Removing the Case Top

For some maintenance procedures, the case top of the controller or the pump may need to be removed. Because interior access is easier with the controller, this method of troubleshooting should be used whenever possible.

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.

8.5.1 Controller Case Top Removal

Troubleshooting for a number of issues can be done on the controller main circuit board. Remove the four screws holding the case top in place (two screws on each side). Lift the cover straight up and off.

Figure 8-5 Controller case top screws (2 of 4 shown)

8.5.2 Pump Case Top Removal

Some maintenance and troubleshooting procedures require accessing the pump module interior. Remove the six screws holding the case top in place (three screws on each side). Lift the cover straight up and off.

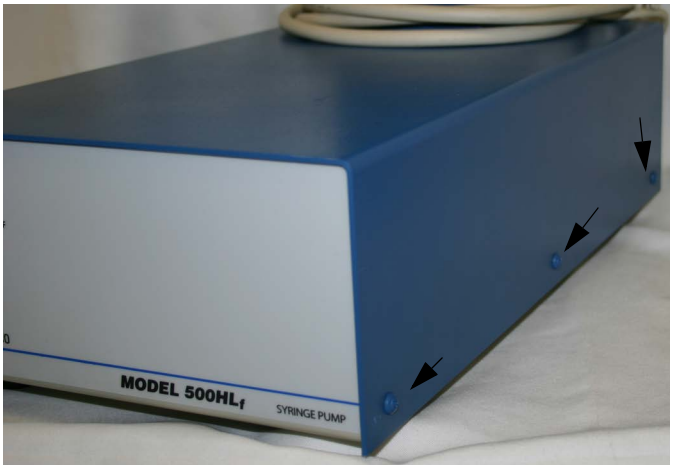


Figure 8-6 Pump case top screws (3 of 6 shown)

8.6 Lubrication

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

The pump has an easy-to-access lube wheel that keeps the main gears lubricated during operation. See Figure 8-7. For your convenience, a lubrication kit (containing Never-seez and DUOLEC 1608 lubricants) is included in your pump accessory package.

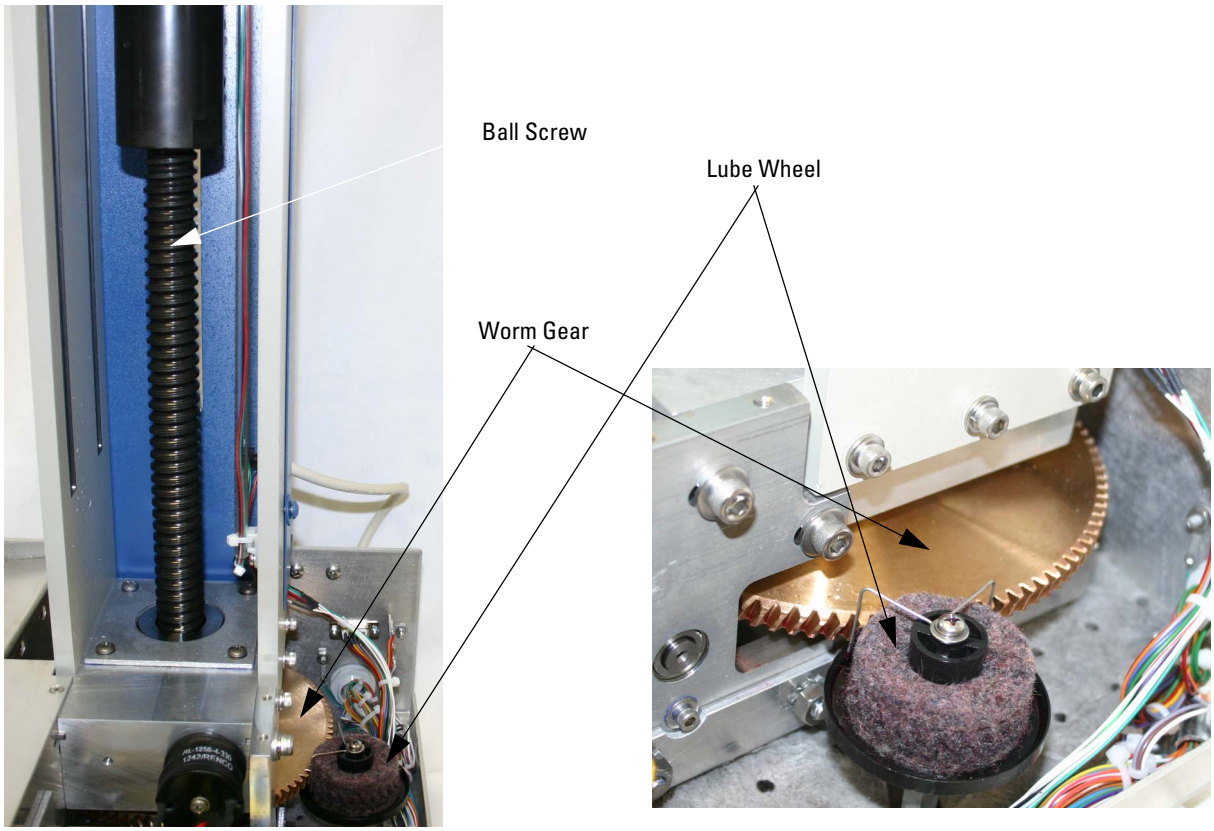


Figure 8-7 Gear train lubrication and motor drive service

Worm / Worm Gear

The worm and worm gear are lubricated by a lubrication wheel. Apply DUOLEC 1608 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 DUOLEC 1608 lubrication on the worm and worm gear. Do not substitute.

8.6.1 Ball Nut

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

1. Remove the case top, as detailed in section 8.5, 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.

The precision thrust bearing at the base of the ball screw (refer to Figure 8-7) is factory lubricated and should not need re-greasing.

8.7 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 8.7.1) or a liquid modifier such as methanol (see Section 8.7.2).

8.7.1 Gas Solvent Changeover

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

1. Close the valve on the fluid supply tank so that no solvent is supplied to the system.
2. Turn the controller ON.
3. Run the pump until the cylinder is empty. 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. Cycle the pump between REFILL and RUN a few times, opening and closing the appropriate valves at the proper time to purge any remaining gas from the pump. Use about 10 - 20 mls per stroke to purge.

8.7.2 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 CONST FLOW > RUN. You will be asked to designate which pump if more than one is present.
2. Press a softkey to run the desired pump.
3. Run the pump until the message “CYLINDER EMPTY” is displayed.
4. Place the pump inlet line in a flask containing a compatible solvent or a detergent solution.
5. Press REFILL. You will be asked to designate the pump to refill if more than one is present. Press a softkey to refill the pump.
6. Fill the pump and repeat this procedure several times.
7. 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 the new liquid solvent.

☑ Note

Do not leave buffer solutions which contain dissolved salts or corrosive buffers 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.

HL_f 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)
线路板 Circuit Boards	X	O	O	O	O	O
液晶显示 LCD Display	X	O	O	O	O	O
电解电容 Capacitor	O	O	O	O	X	O
接线 Wiring	O	O	O	O	X	O
内部电缆 Internal Cables	O	O	O	O	X	O
外部电缆 External Cables	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	O	O	O	O	X	O
小键盘 Keypad	O	O	O	O	X	O
直流电机 DC Motor	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.

Radio Interference Statement

FCC

This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which the user will be required to correct the interference at his own expense.

Canada

This ISM apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Ce générateur de fréquence radio ISM respecte toutes les exigences du Règlement sur le materiel brouilleur du Canada.

CERTIFICATE OF COMPLIANCE

Certificate Number	20140501-E221183
Report Reference	E221183-20020730
Issue Date	2014-MAY-01
Issued to:	TELEDYNE ISCO, A BUSINESS UNIT OF TELEDYNE INSTRUMENTS INC 4700 SUPERIOR ST LINCOLN NE 68504
This is to certify that representative samples of	LABORATORY EQUIPMENT FOR USE IN HAZARDOUS LOCATIONS See Addendum Page
	Have been investigated by UL in accordance with the Standard(s) indicated on this Certificate.
Standard(s) for Safety:	ANSI/ISA 12.12.01 - Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations; CAN/CSA C22.2 No. 213-M1987 - Non-incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations
Additional Information:	See the UL Online Certifications Directory at www.ul.com/database for additional information

Only those products bearing the UL Listing Mark for the US and Canada should be considered as being covered by UL's Listing and Follow-Up Service meeting the appropriate requirements for US and Canada.
The UL Listing Mark for the US and Canada generally includes: the UL in a circle symbol with “C” and “US” identifiers: c UL us the word “LISTED”; a control number (may be alphanumeric) assigned by UL; and the product category name (product identifier) as indicated in the appropriate UL Directory.

Look for the UL Listing Mark on the product.

William R. Carney

William R. Carney, Director, North American Certification Programs

UL LLC

CERTIFICATE OF COMPLIANCE

Certificate Number	20140501-E221183
Report Reference	E221183-20020730
Issue Date	2014-MAY-01

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements.

USL, CNL: Laboratory equipment for hazardous locations:
Class I, Division 2, Groups A, B, C and D.

Syringe Pump: Models 65HL, 100HLM, 260HL, 500HL, 1000HL, 65HLX, 100HLX, 260HLX, 500HLX, 1000HLX, 65HLf, 65HLfX, 100HLf, 100HLfX, 260HLf, 260HLfX, 500HLf, 500HLfX, 1000HLf, 1000HLfX.

Controller: Model HazLoc Pump Controller.

USL, CNL: Rebuilt Laboratory equipment for hazardous locations:
Class I, Division 2, Groups A, B, C, D.

Syringe Pump: Models 65HL, 100HLM, 260HL, 500HL, 1000HL, 65HLX, 100HLX, 260HLX, 500HLX, 1000HLX, 65HLf, 65HLfX, 100HLf, 100HLfX, 260HLf, 260HLfX, 500HLf, 500HLfX, 1000HLf, 1000HLfX.

Controller: Model HazLoc Pump Controller.

William R. Carney

William R. Carney, Director, North American Certification Programs

UL LLC