D-Series Pumps

Installation and Operation Guide

TELEDYNE ISCO
Everywhereyoulook™

Part #69-1243-867 of Assembly #60-1243-766

Revision X: February 27, 2012

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 the problem persists, call or e-mail the Teledyne Isco Technical Service Department for assistance. Simple difficulties can often be diagnosed over the phone.

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

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

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

Contact Information

Customer Service

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

Technical Support

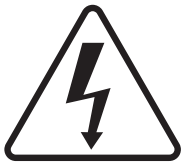
Phone:	(800) 775-2965	(Analytical)
	(866) 298-6174	(Samplers and Flow Meters)
Email:	IscoService@teledyne.com	
Return equipment to:	4700 Superior Street, Lincoln, NE 68504-1398	

Other Correspondence

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

Revised March 17, 2009

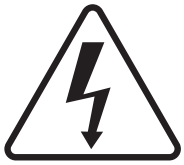
Warnings and Cautions



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.

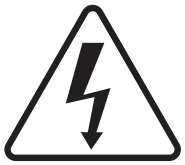
Symboles de Sécurité



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

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

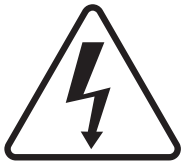
Warnungen und Vorsichtshinweise



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!

- EXPLOSION WARNING -

WARNING
Teledyne Isco D Series Pumps, SFX 2-10 and SFX 220 Extractors are NOT EXPLOSION PROOF.

Teledyne Isco SFX System and D Series Syringe Pump Safety Note when using a flammable fluid

The Teledyne Isco SFX system and syringe pumps must be placed within a properly operating vent hood (fume cupboard), when using ethane or any other flammable gas. Ensure that all SFE tubing connections are completely free of any gas leaks by performing the leak test using CO_2 (detailed in Section 2 of the D Series pump manual, Section 5 of the SFX 2-10 manual and Section 6 of the SFX 2-10, 220, and SFX 3560 manual). There must absolutely be **NO** gas leaks present before introducing the flammable gas. In a temperature-stable, leak-free system, the flow rate, as registered by the pump, should settle to a value below 0.01 ml/min after 15, minutes during a static extraction.

Important: When using a Teledyne Isco extractor (either SFX 2-10, SFX 220, SFX 3560) be absolutely sure the built-in venting fan (a brushless motor) is operating properly.

The Teledyne Isco D Series Syringe Pumps and the SFX units, use *brush-type* drive motors. Minor modifications to the pumps may render them safer, especially in the rare event of catastrophic piston seal failure. **However, these modifications will not make these pumps explosion proof.**

- Remove the front and back cylinder covers located on the ball screw tower. This will allow any escaped gas to quickly dissipate away from the pump cylinder area and to reduce the amount entering the motor compartment.
- Seal the syringe pump motor compartment with tape and purge it with a continuous flow of nitrogen (N_2) gas. This will also reduce the possibility of accumulating an explosive mixture around the motor and relays.
- For further information, telephone Teledyne Isco at (800)775-2965, or fax (402)465-3085 to consult the Teledyne Isco Service Department.

USE THE Teledyne Isco SFE SYSTEM AND SYRINGE PUMPS IN THESE POTENTIALLY HAZARDOUS APPLICATIONS AT YOUR OWN RISK!

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- AVERTISSEMENT D'EXPLOSION -

AVERTISSEMENT

Les pompes de Série 'D' Teledyne Isco et l'extracteur SFX 2-10, SFX 220, et SFX 3560 ne sont pas à l'épreuve d'explosion!

Remarque de sûreté concernant l'usage d'un fluide inflammable avec les pompes à seringue d'Isco Série 'D' et le système SFX.

Le système SFX et pompes à seringue Teledyne Isco doivent être placées à l'intérieur d'une hotte chimique fonctionnelle, quand vous utilisez éthane C_2H_6, ou tout autre gaz inflammable. Assurez-vous que toute la tuyauterie SFE est complètement scellée avec aucune fuite de gaz en exécutant une épreuve de fuite en utilisant du CO_2. (Cette méthode est détaillée à la partie 2 du manuel de la pompe Série 'D'et à la partie 2 du manuel SFX 2-10, SFX 220, et 3560.) Il faut absolument qu'il n'y ait aucune fuite de gaz avant d'introduire le gaz inflammable au système. À partir d'un système à température stable et sans aucune fuite de gaz, la valeur du flot qui est indiqué par la pompe, devrait se stabiliser à une valeur moins de 0,01 ml/min après 15 minutes, pendant une extraction statique.

Important: Quand vous utilisez un extracteur Teledyne Isco SFX 2-10, SFX 220, et 3560, soyez absolument certain que le ventilateur (du moteur *sans brosses*) fonctionne correctement. Quand vous installez l'extracteur, assurez-vous qu'il y a un espace vide de 15 centimètres au moins entre le mur et l'arrière de l'extracteur pour assurer ventilation adéquate.

Le système SFE et les pompes de série 'D' utilisent les moteurs de courant continu. Ils possédent *des collecteurs et brosses* qui produisent des décharges électriques (étincelles) entre eux quand les moteurs fonctionnent normalement. Ces décharges, aussi bien que celles qui sont produites aux contacts des relais pourraient faire exploser un mixture d'air et de gaz inflammable. De petites modifications aux pompes peuvent les rendre moins dangereuses, surtout dans le cas rare d'une panne catastrophique du joint d'étanchéité du piston. **Cependant, il n'y a aucune modification qui fera ces pompes à l'épreuve d'explosion!**

- Enlevez les couvercles de devant et d'arrière du cylindre qui sont situés sur la tour de la pompe. Cela permettra au gaz qui s'échappe de dissiper plus rapidement loin de la pompe et réduira aussi la quantité de gaz qui entre dans le compartiment du moteur.
- Scellez le compartiment du moteur de la pompe avec un ruban adhésif et circulez un flot continu d'azote (N_2) à l'intérieur du compartiment. Cela réduira aussi la possibilité d'accumuler une mixture explosive autour du moteur et relais, où se trouvent la première possibilité des étincelles électriques.
- Pour l'information supplémentaire, téléphonez gratuitement (800) 775-2965, ou télécopiez (402) 465-3085 pour consulter le département de service technique.

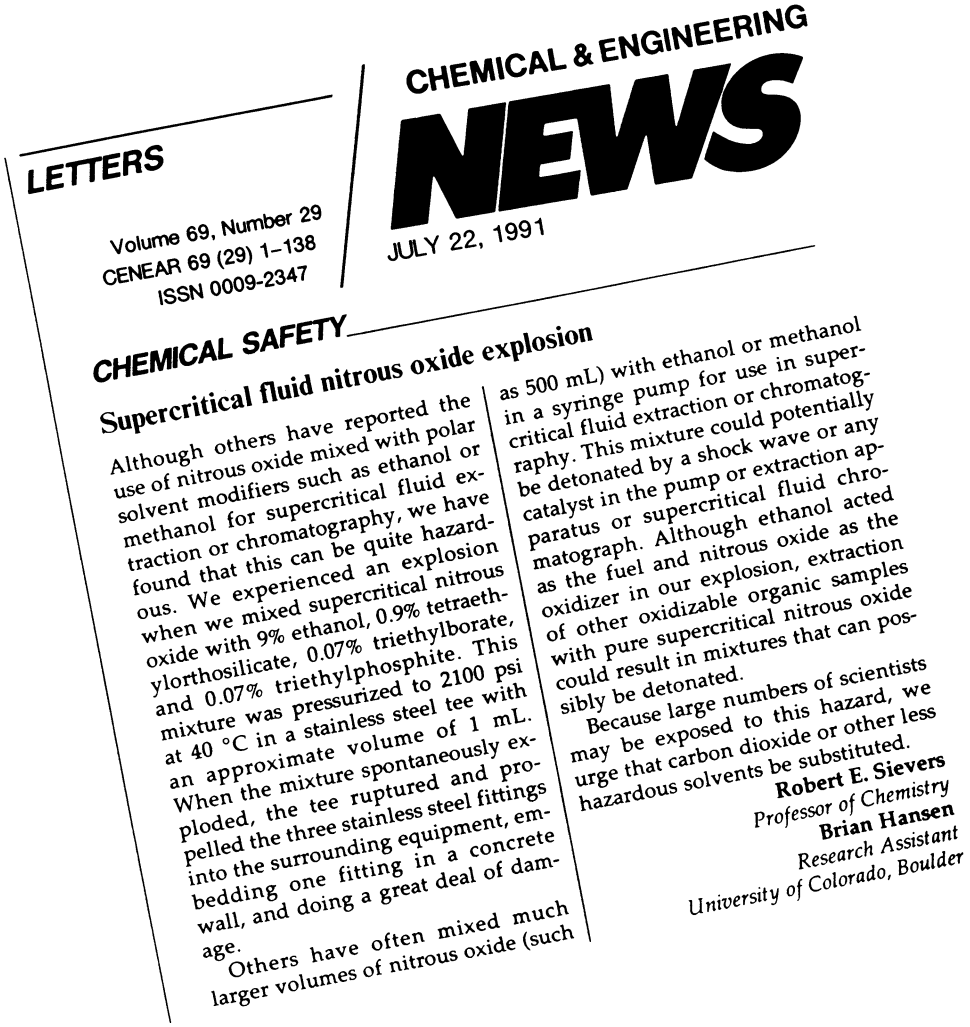
UTILISEZ LE SYSTÈME SFE ET LES POMPES À SERINGUE TELEDYNE ISCO DANS TELLES APPLICATIONS POTENTIELLEMENT HASARDEUSES Á VOS RISQUES ET PÉRILS!

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.

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.

Commonly Ordered Replacement Parts for the D Series Syringe Pumps

Description		Part Number
Cylinder Seals General:		
65D	0-1379 bar	202-9096-08
65DM	0-689.5 bar	202-9096-08
100DX/DM	0-689.5 bar	202-9090-75
260D	0-517.1 bar	202-9091-06
500D	0-258.6 bar	202-9091-56
1000D	0-137.8 bar upper seal	202-9990-25
1000D	0-137.8 bar lower seal	202-9990-23
(For more information on seals, refer to Table 2A-6)		
65D		
Inlet/Outlet fittings:		
¼" F250C Gland		209-0164-02
¼" F250C Collar		209-0164-03
¼" F250C Plug		209-0164-05
65DM		
Inlet/Outlet fittings:		
Valco - ⅛" Nut		209-0169-27
⅛" Ferrule		209-0169-41
⅛" Plug		209-0166-80
⅛ – 1⁄16" Tubing Reducer		209-0169-42
100DX/DM and 260D		
Inlet/Outlet fittings:		
Valco - ⅛" Nut		209-0169-27
⅛" Ferrule		209-0094-07
⅛" Plug		209-0166-80
⅛ – 1⁄16" Tubing Reducer		209-0169-42
500D		
Inlet/Outlet fittings:		
⅛" Tubing Connector to ⅛" NPT		209-0161-01
⅛" NPT Plug		209-0168-00
⅛ – 1⁄16" Tubing Reducer		209-0162-00
1000D		
Inlet/Outlet fittings:		
¼" NPT Plug		209-0168-09
¼" NPT Connector to ¼" tubing		202-1063-36
Stainless Steel Tubing:		
1⁄16" OD × 0.009" ID		004-7462-51
1⁄16" OD × 0.020" ID		004-7300-21
⅛" OD × 0.069" ID		004-7302-22

D Series Syringe Pumps

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D Series Syringe Pumps

Section 1 Introduction

1.1 Introduction

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

1.1.1 Specifications

The technical specifications for the D Series Syringe Pumps are detailed in Tables 1-1 through 1-7.

> ☑ ***Note***
>
> Underwriters Laboratories (UL) has certified all Series D Pumps with the exception of the 100 Vac versions.

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

Table 1-1 65D Technical Specifications	
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 Vac, 1.5 A maximum 117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 101.09 cm / 13.59 cm
WEIGHT	PUMP 32.8 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	0.01 µl/min to 25 ml/min (for any pressure up to 1379 bar)
FLOW RATE ACCURACY[b]	± 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[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	2.55 nl
REFILL TIME	1.7 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 40 ml/min at any pressure from 0 to 1379 bar
PRESSURE RANGE	0.6895 to 1379 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	± 0.015% of full scale/°C
HUMIDITY	95% maximum
CYLINDER CAPACITY	67.97 ml
DEAD (HEADSPACE) VOLUME[e]	1.30 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 Vac versions.
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.

Table 1-2 65DM Technical Specifications	
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 Vac, 1.5 A maximum 117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 45.0 cm / 30.48 cm Height: 103.0 cm / 13.59 cm
WEIGHT	PUMP 33.2 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	0.01 µl/min to 30 ml/min (for any pressure up to 689 bar)
FLOW RATE ACCURACY[b]	± 0.3% of setpoint, (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[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	2.55 nl /step
REFILL TIME	1.7 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 40 ml/min at any pressure from 0 to 689 bar
PRESSURE RANGE	0.6895 to 689 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature (± 0.1% FS optional)
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	67.97 ml
DEAD (HEADSPACE) VOLUME[e]	1.30 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 Vac versions.
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.

Table 1-3 100DM Technical Specifications	
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 Vac, 1.5 A maximum 117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 101.09 cm / 13.59 cm
WEIGHT	PUMP 32.8 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	0.01 µl/min to 25 ml/min (for any pressure up to 689.5 bar)
FLOW RATE ACCURACY[b]	± 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[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	4.825 nl
REFILL TIME	3.5 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 30 ml/min at any pressure from 0 to 689.5 bar
PRESSURE RANGE	0.6895 to 689.5 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[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	± 0.0.12% of full scale/°C
HUMIDITY	95% maximum
CYLINDER CAPACITY	102.93 ml
DEAD (HEADSPACE) VOLUME[e]	1.30 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m
NOTES:	

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 Vac versions.
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.

Table 1-4 100DX Technical Specifications	
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 Vac, 1.5 A maximum 117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSION	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 50 ml/min (for any pressure up to 689.5 bar)
FLOW RATE ACCURACY[b]	± 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[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	9.65 nl
REFILL TIME	1.72 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 60 ml/min at any pressure from 0 to 689.5 bar
PRESSURE RANGE	0.6895 to 689.5 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[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	± 0.0.12% of full scale/°C
HUMIDITY	95% maximum
CYLINDER CAPACITY	102.93 ml
DEAD (HEADSPACE) VOLUME[e]	1.30 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 Vac versions.
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.

Table 1-5 260D Technical Specifications	
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 Vac, 1.5 A maximum 117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 101.09 cm / 13.59 cm
WEIGHT	PUMP 32.8 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	See Figure 1-2.
FLOW RATE ACCURACY[b]	± 0.5% (maximum 0.50 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	16.63 nl
REFILL TIME	2.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 107 ml/min at any pressure from 0 to 517.1 bar
PRESSURE RANGE	0.6895 to 517.1 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[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	± 0.15% of full scale/°C
HUMIDITY	95% maximum
CYLINDER CAPACITY	266.05 ml
DEAD (HEADSPACE) VOLUME[e]	2.10 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

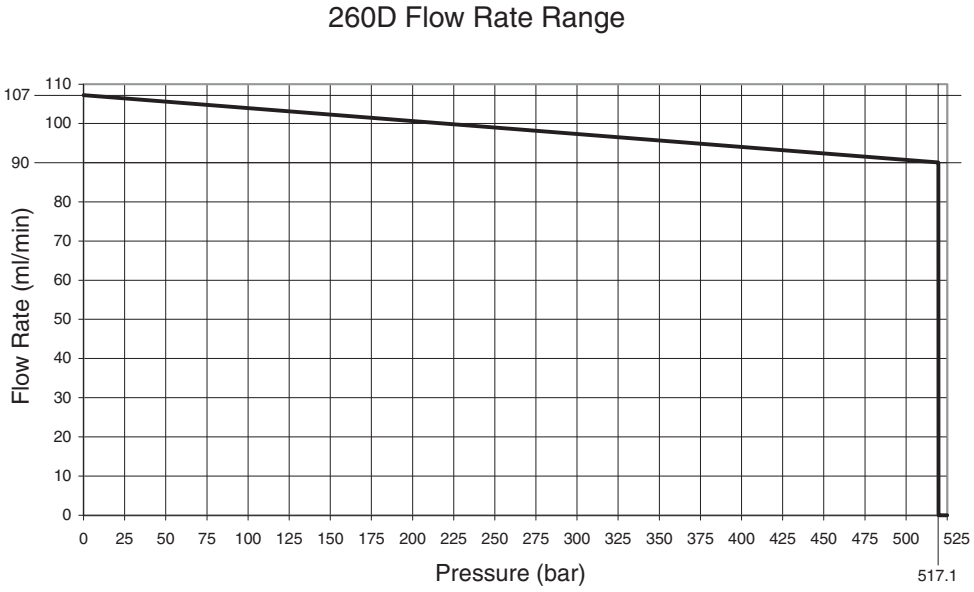
a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 Vac versions.
b. Using water at 137.9 bar and a temperature controlled environment at 30°C.
c. The analog output is an optional accessory.
d. Pressure repeatability specification is based upon re-zeroing 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.

Table 1-6 500D Technical Specifications	
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 Vac, 1.5 A maximum 117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 102.36 cm / 13.59 cm
WEIGHT	PUMP 33.25 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	See Figure 1-3.
FLOW RATE ACCURACY[b]	± 0.5% (maximum 1.0 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	31.71 nl
REFILL TIME	2.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 204 ml/min at any pressure from 0 to 258.6 bar
PRESSURE RANGE	0.6895 to 258.6 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[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	± 0.15% of full scale/°C
HUMIDITY	95% maximum
CYLINDER CAPACITY	507.38 ml
DEAD (HEADSPACE) VOLUME[e]	4.00 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 Vac versions.
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.

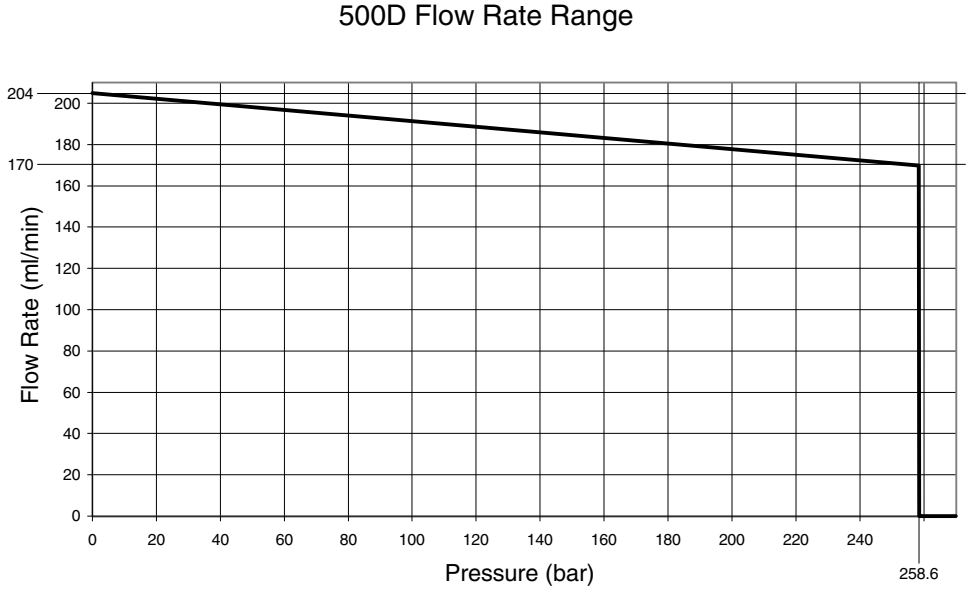
Table 1-7 1000D Technical Specifications	
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 Vac, 1.5 A maximum 117 ± 12 Vac, 1.5 A maximum 234 ± 23 Vac, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 102.36 cm / 13.59 cm
WEIGHT	PUMP 38.5 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	See Figure 1-4.
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	25.38 nl
REFILL TIME	2.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 408 ml/min at any pressure from 0 to 137.9 bar
PRESSURE RANGE	0.6895 to 137.9 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[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. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 Vac versions.
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.



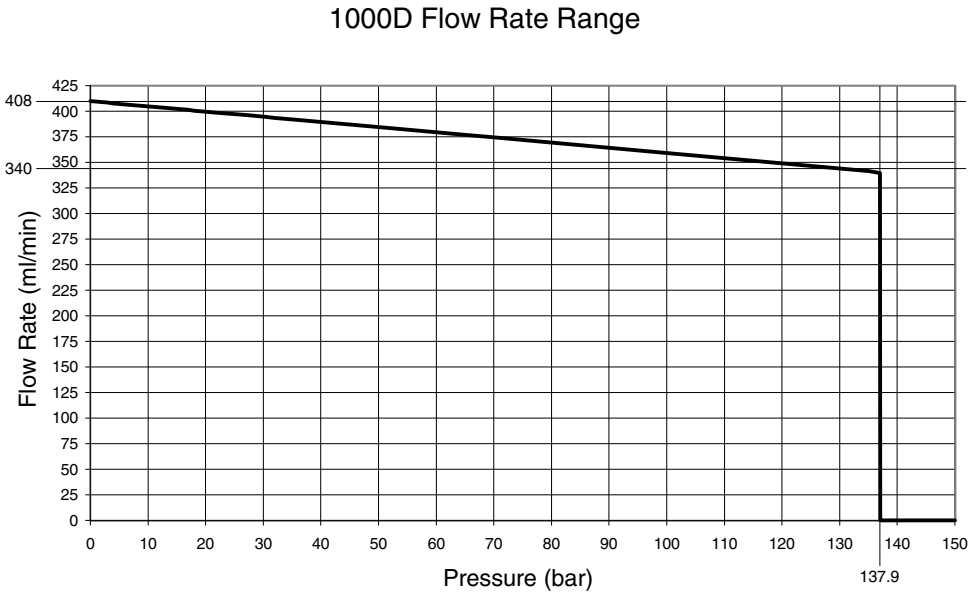
Flow Rate (ml/min)	Max. Pressure (bar)
0 to 90	517.1
90 to 107	(107.23 ml/min – flow rate) × 30

Figure 1-2 260D flow rate range



Flow Rate (ml/min)	Max. Pressure (bar)
0 to 170	258.6
170 to 204	(204.9 ml/min – flow rate) × 7.4

Figure 1-3 500D flow rate range



Flow Rate (ml/min)	Max. Pressure (bar)
0 to 340	137.9
340 to 408	(409.8 ml/min – flow rate) × 1.9756

Figure 1-4 1000D flow rate range

Table 1-8 Pump Controller Key Functions

Key	Description
ON/STANDBY	Two-position toggle switch turns controller on and activates drive motor to maintain position. Standby disables the drive motor and halts the controlling processor.
A, B, C, D	Softkeys; used to select displayed options.
PRGM GRAD	Program gradient: Puts 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.
HELP	Provides information.
HOLD	Freezes the program clock. The unit will continue at the current gradient parameters.
REFILL	Turns on pump drive motor to move piston downward at a rate previously programmed.
RUN	Turns on pump drive motor to move piston upward in a previously programmed mode, such as “CONSTANT FLOW” or “CONSTANT PRESSURE.”
STOP	Stops the drive motor.
ENTER	Enters selected values to memory.
NUMBER KEYS	These keys are used to make menu selections and enter values when setting parameters.

1.2 Controls and Indicators

The pump controller, which is designed to conveniently sit on top of the pump base, regulates all pumping functions. Controller input is made through the keypad on the controller front panel. The controller front panel is shown in Figure 1-5 and detailed in Table 1-9. Table 1-8 details the key functions.

The rear panel of the pump controller contains several input and output connectors, detailed in Table 1-10, and shown in Figure 1-6.

The only operational control on the pump itself is the mains power switch, shown in Figure 1-8. The rear panel contains several connectors, detailed in Table 1-11, and shown in Figure 1-7.

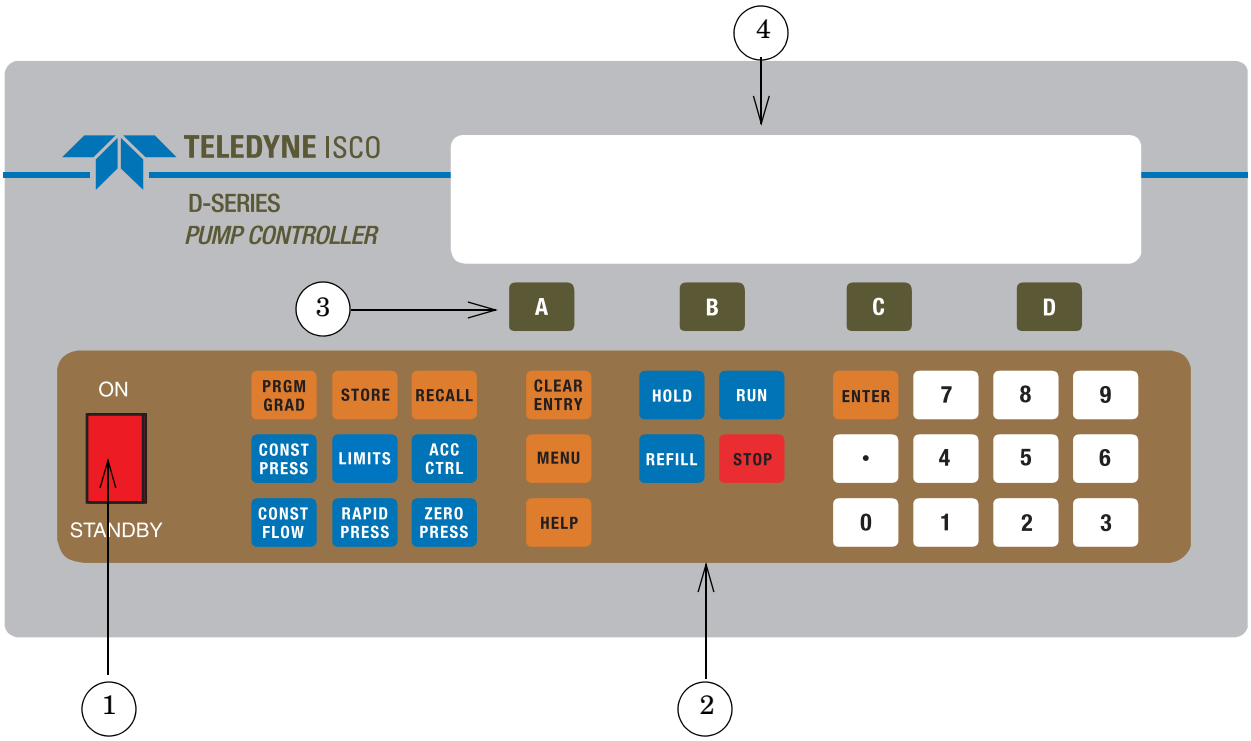


Figure 1-5 Pump controller key functions

Table 1-9 Pump Controller Front Panel Label

Item No. on Figure 1-5	Connector	Description
1	On/Standby switch	Turns instrument off and on. (Does not disconnect power.)
2	Programming keypad	Used to program controller.
3	Softkeys	Labeled A, B, C, or D; used to select menu items displayed on the liquid crystal display.
4	Liquid crystal display	40 Characters × 4 line.

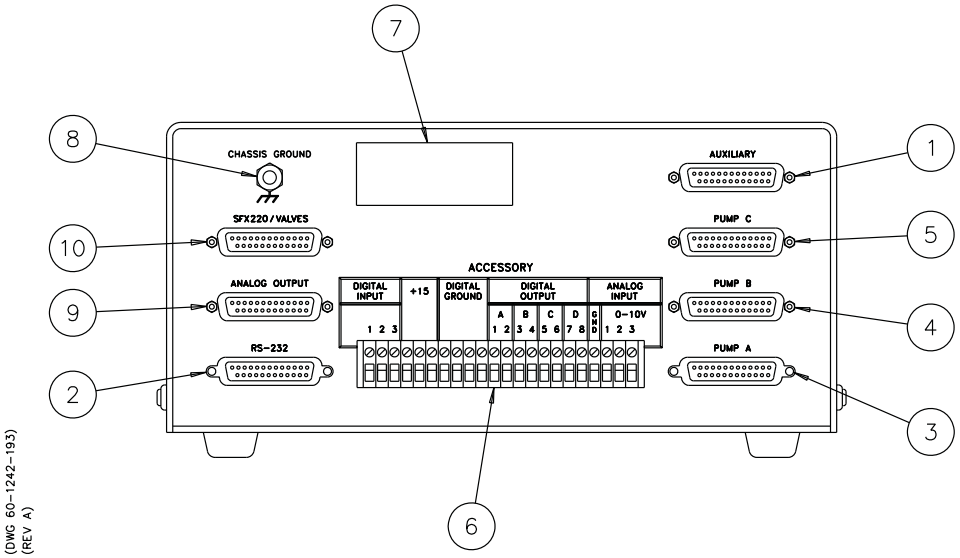


Figure 1-6 Pump controller rear panel connectors

Table 1-10 Pump Controller Rear Panel Connectors

Item No. on Figure 1-6	Connector	Description
1	AUXILIARY	Provides connection for pump external controls and to future accessories.
2	RS-232	This serial port connector may be used with an RS-232 cable to place the pump under computer control.
3	PUMP A	This plug connects the control cable from the pump rear panel. This connection should be secured with the thumbscrews. **IMPORTANT**: The pump A connector is the only input power connector on the rear panel of the controller. During single pump operation, the pump must be attached to this connector to supply power to the controller. WARNING Do not connect or disconnect the control cable when the pump is connected to the mains voltage.
4	PUMP B	This connector is only used during multiple pump operation. The control cable from the rear panel of the second pump is attached to this connector.
5	PUMP C	This connector is only used during multiple pump operation. The control cable from the rear panel of the third pump is attached to this connector.
6	ACCESSORY	These terminals allow connection of input and output signals (such as analog controls and external RUN/STOP).
7	SERIAL TAG	This tag indicates the serial number of the instrument.
8	CHASSIS GROUND	Ground point for high static or remote controller installations.
9	ANALOG OUTPUT	Optional circuit provides flow rate and volume outputs. See section 3.9.
10	SFX220/VALVES	Optional circuit provides motor drive for valve operation.

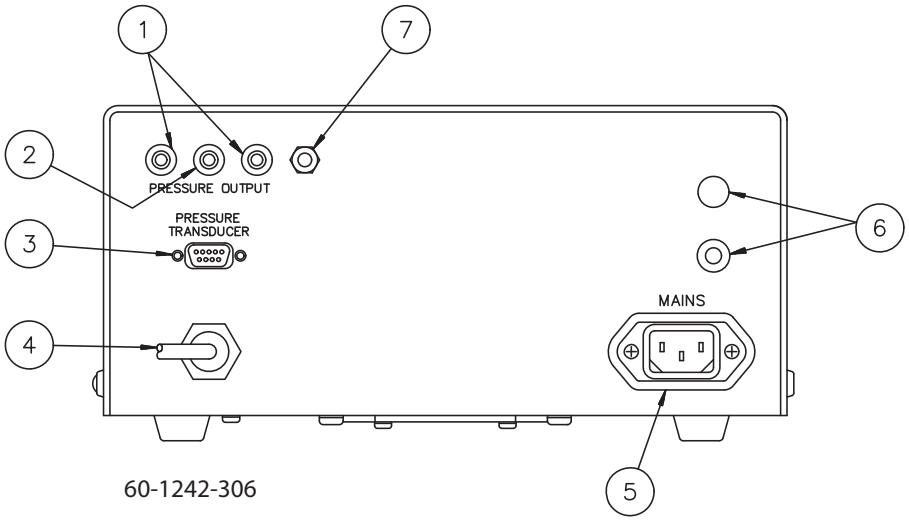


Figure 1-7 Pump rear panel connectors

Table 1-11 Pump Rear Panel Connectors

Item No. on Figure 1-7	Connector	Description
1	Pressure outputs	Two red binding post/banana jacks providing pressure output voltages. Pump — Left Jack VDC/psi — Right Jack VDC/psi 65D — 1.0 V/2000 psi — 0.1 V/2000 psi All others — 1.0 V/1000 psi — 0.1 V/1000 psi
2	Ground	A black binding post/banana jack providing a connection to circuit common.
3	Pressure transducer	The pressure transducer cable must be plugged in for the pump to operate.
4	Control cable	This cable connects the pump to the controller.
5	Mains	IEC power connector with EMI filter.
6	Fuses *	Limits pump current drawn from main power supply. Replace with same type: (“T” time delay fuses) 1 - 2.0 Amp for 100/117 volt operation 2 - 1.0 Amp for 234 volt operation To remove, rotate cap counterclockwise.
7	Chassis ground	Ground point for high static installations.
*	Fuses not replaceable by the operator	F101 4.0 Amp “T” F102, F104 1.5 Amp “T” F103 0.75 Amp “T”

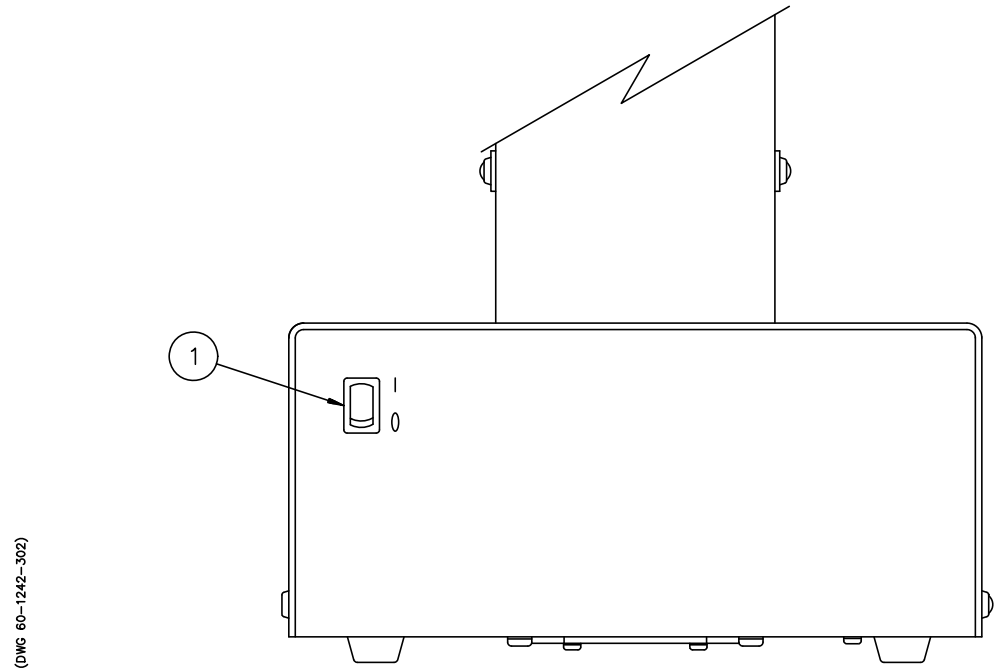


Figure 1-8 Pump front panel controls

Table 1-12 Pump Front Panel

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

1.3 Unpacking

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

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

1.4 Electrical Connections

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

⚠ CAUTION

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

1. Connect the pressure transducer cable (which originates from the top of the pump cylinder) to the nine pin sub-D PRESSURE TRANSDUCER connector on the pump rear panel (Figure 1-7). Be sure to tighten the thumbscrews.
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 thumbscrews. This cable must be plugged into the PUMP A connector.

☑ Important

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

3. Check the serial number tag to make sure the voltage rating of the pump is correct.
4. Connect the line cord to the MAINS connector on the back of the pump.

1.5 Preliminary Checkout

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

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

> ☑ ***Note***
>
> If adding a new pump to the controller, a hard and soft reset need to be completed.

1. Before connecting the line cord, make sure the voltage rating on the serial tag matches your outlet's voltage. Plug in the line cord. Set the pump mains power switch to ON. Set the controller ON/STANDBY switch to ON.
2. The display will briefly show the software revision on the first line; and the pump model(s) connected to the controller on the following lines, Figure 1-9.

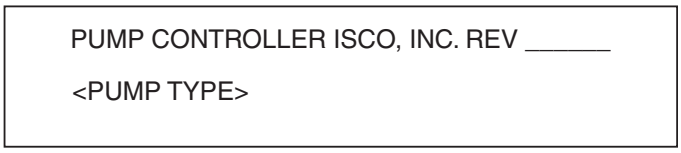


Figure 1-9 Status Screen

3. 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.
4. Press the orange MENU key on the controller front panel.
5. Press number 6 to set the display contrast. Use softkeys B and C to set the optimum contrast for your viewing conditions. Press softkey D, PREVIOUS, to return to the menu screen.
6. Press number 1 to select UNITS.
7. Press number 3 to select PSI for the pressure units.
8. Press number 5 to select ML/MIN for the flow units. The first line of the display will show the selected units.

9. Press softkey D, PREVIOUS, to return to the main menu.
10. Press softkey D, RETURN, to exit the main menu.
11. 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.
12. 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.

13. 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.
14. Once the setpoint and flow rate match, press the STOP key.

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

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

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

D Series Syringe Pumps: Models 65DM, 100DM, 100DX, 260D

Section 2A 65DM, 100DM, 100DX, and 260D Liquid System Connections & Accessories

About This Section:

The following section is divided into four parts, 2A through 2D. Section 2A covers the liquid system connections and accessories for the Teledyne Isco 65DM, 100DM, 100DX, and 260D syringe pumps. Sections 2B, 2C, and 2D cover the same topics for the 500D, 1000D, and 65D syringe pumps, respectively.

The installation procedures for the D Series pumps have been divided in this way for your convenience. The 65DM, 100DM, 100DX, and 260D pumps all come with ⅛" standard Valco ports. The 500D and 1000D ports are ⅛" pipe thread fittings. The 65D uses AE F250C high pressure fittings. Because of this difference, the packages, tubing, and options have different part numbers. Additionally, these pumps are typically used for different applications; therefore, the optional kits and accessories differ.

Table 2A-6 is a seal selection chart applicable to all D Series pumps except the 65D.

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

⚠ DANGER

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

2A.1 Introduction

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

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

☑ Note

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

Fluid Connection Accessories (section 2A.3):

Pump refill kit, 2A.3.1
CO_2 cylinder connection package, 2A.3.2
Outlet valve package, 2A.3.3
In-line filter package, 2A.3.4

Temperature and Pressure Controls (section 2A.4):

Cylinder insulating cover, 2A.4.1
Cooling jacket package, 2A.4.2
Back pressure regulators, 2A.4.3

Nitrogen Purge (section 2A.5)

Optional Kits and Instrumentation (section 2A.6)

Optional Seal Selection (section 2A.7)

Optional Accessories (section 2A.8)

2A.2 Liquid System Connections

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

2A.2.1 Ports

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

⚠ DANGER

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

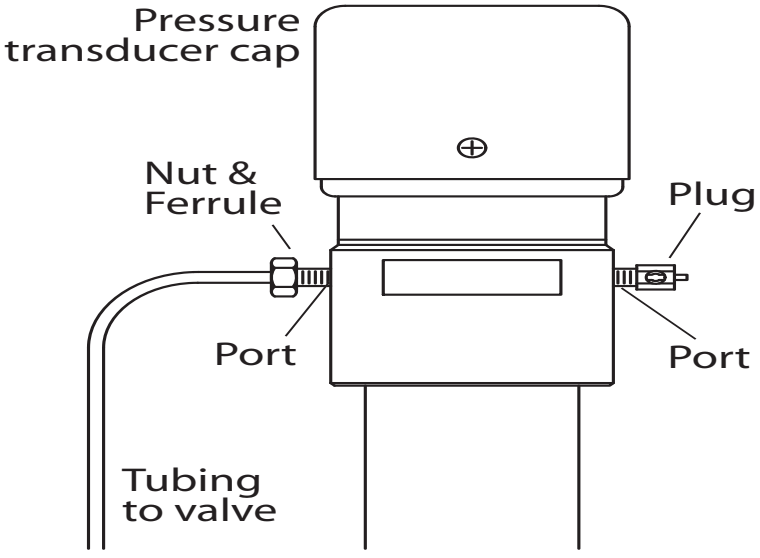


Figure 2A-1 Liquid system plumbing connections

2A.2.2 Installation Tips

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

2A.2.3 Tubing Cutting

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

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

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

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

To cut the tubing by hand

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

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

2A.2.4 Accessory Package

The accessory packages for all pumps (#60-1249-012 for 260D, #60-1249-028 for 65DM, or #60-1249-015 for 100DM/DX) contain Valco fittings for 1/8" tubing, which allow you to attach tubing to the pump, a reducing adapter for use with 1/16" tubing, and the appropriately sized cylinder seals.

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

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

⚠ DANGER

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

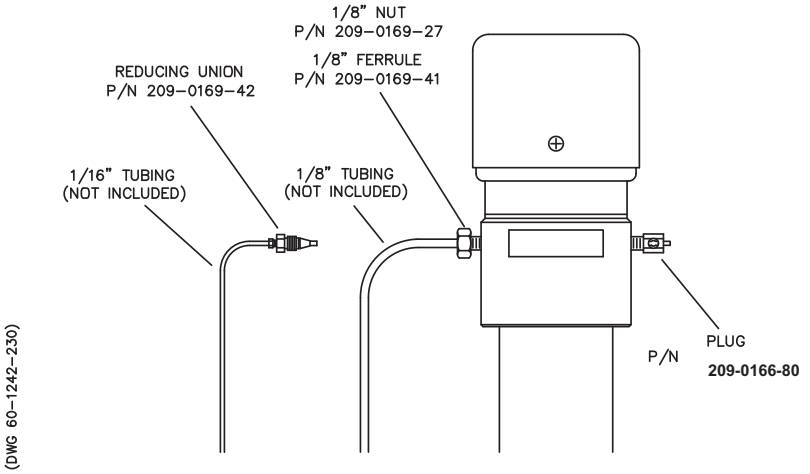


Figure 2A-2 Accessory package installation

To install the 1/16" fittings

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

☑ *Note*

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

2A.2.5 Drain Tube

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

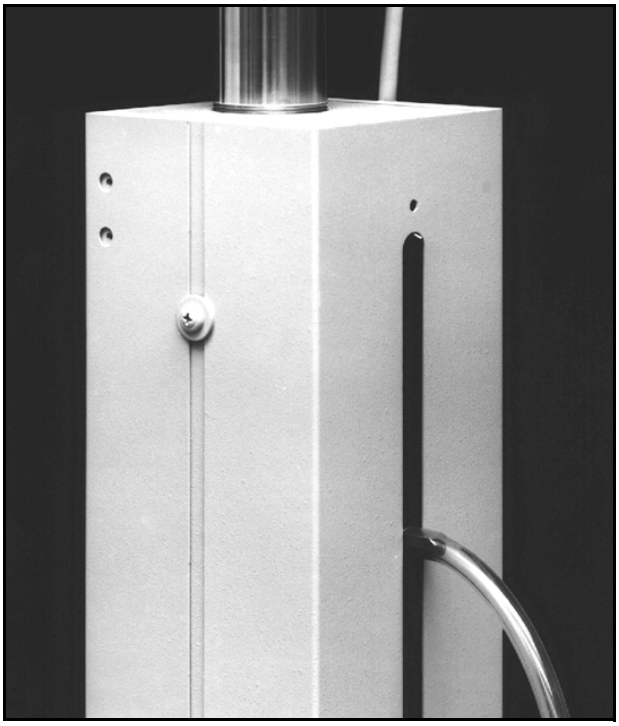


Figure 2A-3 Drain tube installation

2A.3 Fluid Connection Accessories

The optional accessories discussed in this section are used to make fluid connections from the pump(s) to another apparatus. These include devices such as a CO_2 tank, fluid reservoirs, etc.

2A.3.1 Manual Refill Kit

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

Table 2A-1 Manual Refill Kit Package (P/N 68-1247-077)

Qty.	Part Number	Description
1	60-1243-659	Valve spacer
1	209-0098-05	2-way straight valve, 1/8" OD, bracket mounted
1	023-0504-02	1.5 m - 0.065 ID PTFE tubing
1	60-1243-658	Stainless steel tubing, 1/8" OD × 0.069 ID
1	209-0161-66	Gland nut 1/8" OD tubing
1	209-0161-67	Ferrule 1/8" OD tubing
1	209-0169-27	Column nut, 1/8", zero volume
1	209-0169-41	Ferrule, 1/8", zero voume
1	209-9012-10	10 micron filter
1	60-1243-391	1.5 m coiled, stainless steel tubing, 1/8" OD × 0.069 ID
Appropriate screws and washers also included		

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

1. To attach the 2-way valve to the pump housing, use the valve (see Figure 2A-4): spacer block and screws provided.
2. Then connect the pre-bent ⅛" stainless steel tubing from the valve to the pump inlet. Use the ⅛" nut and ferrule to connect the tubing at the inlet and the valve fittings to connect the tubing at the valve.
3. Then connect the 1.5 m PTFE refill tubing (with the filter) to the port of the 2-way valve, using the valve fittings.

   or,

   When connecting to pressurized sources in SFC applications, use the ⅛" × 1.5 m stainless steel tubing (P/N 60-1243-391) **without** a filter. An in-line filter is contained in the CO_2 connection package.

⚠ DANGER

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

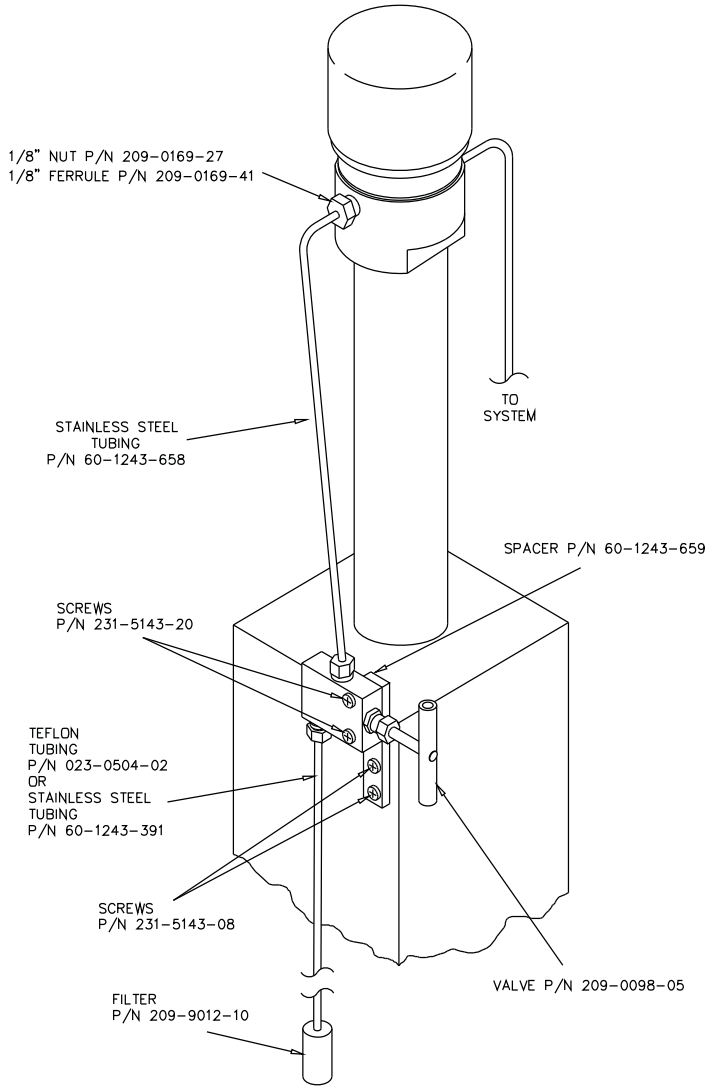


Figure 2A-4 Refill kit installation

2A.3.2 CO_2 Cylinder Connection Package

The optional CO_2 connection package is part number 68-1247-043, Table 2A-2.

Table 2A-2 CO_2 Cylinder Connection Package (P/N 68-1247-043)

Qty.	Part Number	Description
1	209-0161-63	Reducing connector 1/8" to 1/4"
1	209-0161-16	1/4" × 2 1/2" nipple
1	209-0161-15	0.830-14 nut
1	209-0161-17	PTFE washer
1	209-0161-64	In-line filter assembly

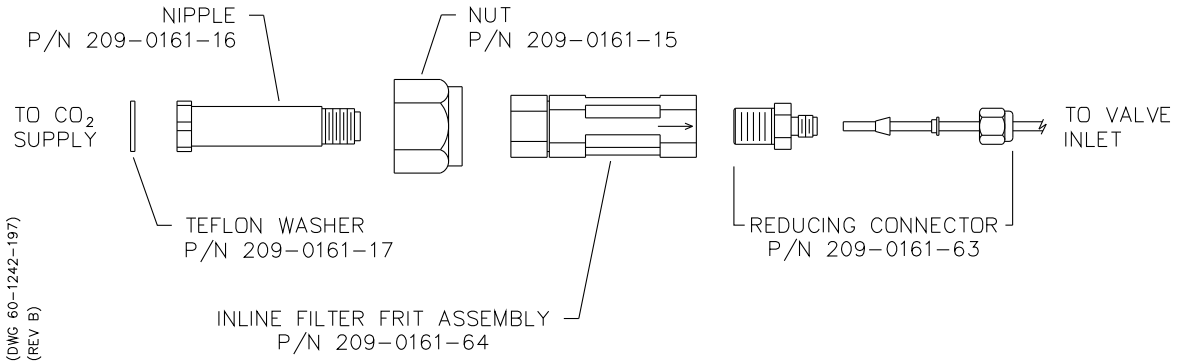


Figure 2A-5 CO_2 package installation

2A.3.3 Manual Outlet Valve Package

The optional manual outlet valve package is part number 68-1247-078, Table 2A-3.

Table 2A-3 Manual Outlet Valve Package (P/N 68-1247-078)

Qty.	Part Number	Description
1	60-1243-659	Valve spacer
1	60-1243-322	5.1 cm - 0.069 ID stainless steel tubing
1	209-0169-27	1/8" nut, zero volume
1	209-0169-41	Ferrule, 1/8" zero volume
1	209-0162-00	1/8" - 1/16" union
1	209-0098-05	2-way straight valve
1	60-1243-658	1/8" OD - 0.069 ID stainless steel tubing
1	60-1243-320	1/16" OD - 0.02 ID × 0.9 m stainless steel tubing
Appropriate screws and washers also included.		

To install the outlet valve package (Figure 2A-6*)*

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

ferrule. Connect the other end to the top port on the valve using the valve fitting.

☑ Note

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

3. Then use the valve fittings to attach the 5.1 cm length of ⅛" OD stainless steel tubing to the port of the 2-way valve.
4. Connect the reducing union, (P/N 209-0162-00) to this 5.1 cm tubing.
5. Connect the 0.9 m length of 1⁄16" tubing between the reducing union and your apparatus. Cut to the desired length.

⚠ DANGER

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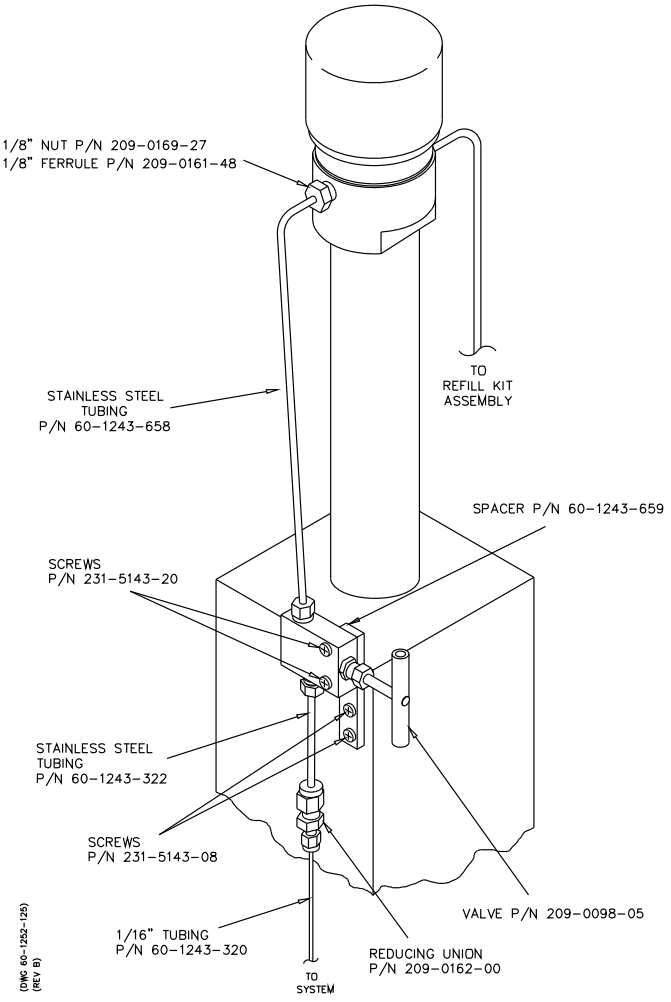


Figure 2A-6 Outlet valve package connection

2A.3.4 In-Line Filter Package The optional in-line filter package (P/N 68-1247-011) should be used when it is important to filter flow exiting the pump. This package (Table 2A-4) contains a 0.5 µm filter and 1⁄16" tubing.

Table 2A-4 Optional in-line Filter Package (P/N 68-1247-011)

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

To install the in-line filter package (Figure 2A-7*)*

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

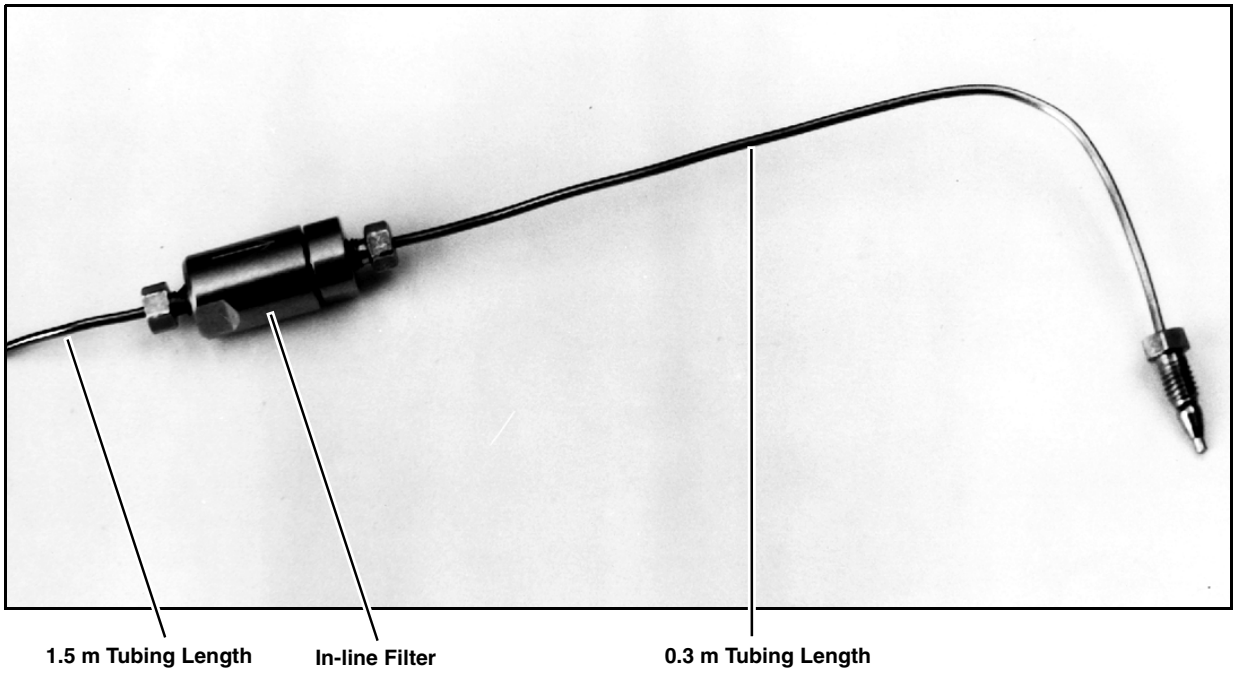


Figure 2A-7 In-line filter package

2A.4 Temperature and Pressure Controls

2A.4.1 Cylinder Insulating Cover

An optional insulation cover (P/N 68-1247-081 for 260D/100DM/DX; 68-1247-085 for 500D) is available to reduce noise (due to temperature fluctuations) and also improve pump performance at flow rates under 500 µl/min.

The cover consists of two pieces which fit over the cylinder, as shown in Figure 2A-8.

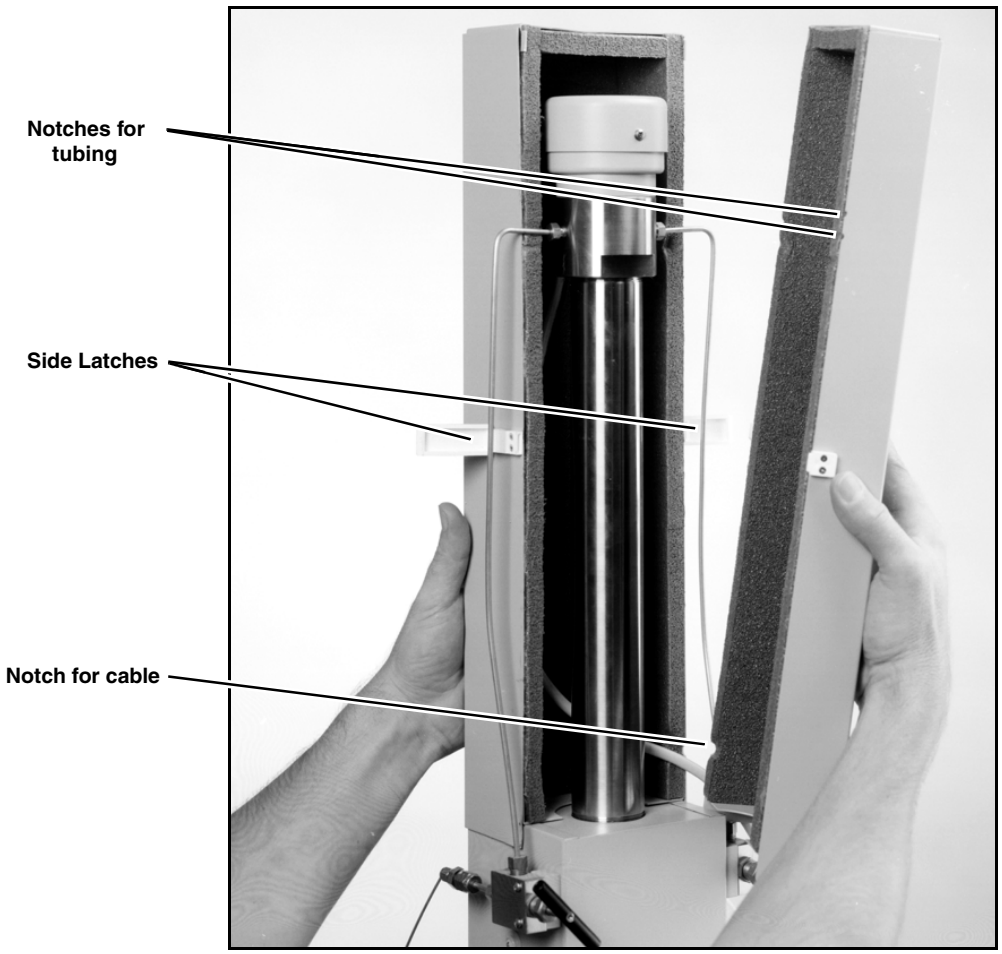


Figure 2A-8 Cylinder insulation cover

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

To install the cylinder insulating cover (Figure 2A-8*)*

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

2A.4.2 Cooling/Heating Jacket

An optional cylinder temperature jacket (68-1247-047) is available for use 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.

To install the cooling/heating jacket (Figure 2A-9*)*

The jacket is very useful for SFC applications where cylinder cooling facilitates pump 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 100 µl/min), where temperature fluctuation can cause flow variations.

Removing the pump cylinder

1. Empty the cylinder.

☑ Note

Be sure the piston is left fully extended.

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

☑ Note

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

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

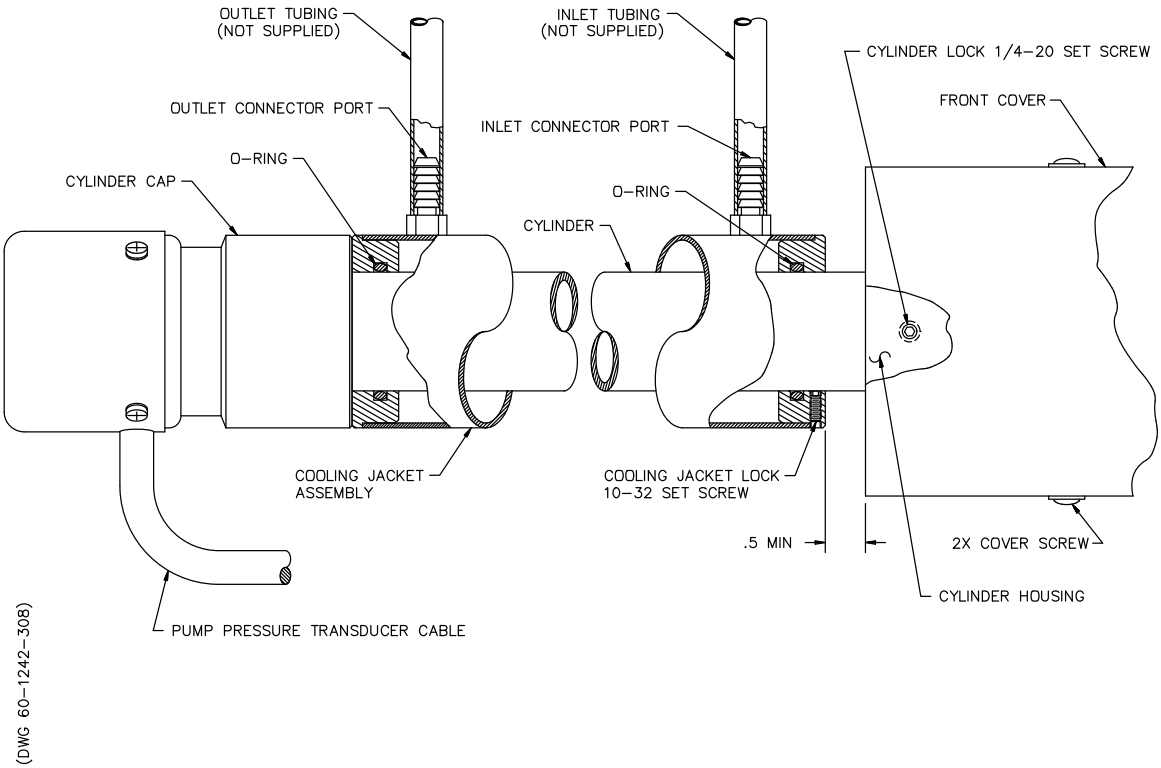


Figure 2A-9 Cooling / Heating jacket installed

Table 2A-5 Packages and Parts

Item Description	Part Number
Temperature control jacket packages for:	
65D, 65DM,100DM,	
100DX, 260D	68-1247-047
500D	68-1247-057
500SP	68-1247-115
1000D	60-5364-199
Temperature control jacket assembly:	
65DM, 100DM, 100DX,	60-1248-053
260D	60-1248-099
500D	60-1248-183
1000D	
Key 3/32" socket	490-0031-54
Inlet/outlet connector (2)	209-0161-00
Installation procedure	60-1242-183
O-ring (2):	
100DM, 100DX, 260D	202-2062-23
500D	202-2062-11
1000D	202-2062-35

To install the cooling jacket

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

☑ Note

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

⚠ CAUTION

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

Reassembling the pump

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

☑ Note

Anytime you adjust fittings on the cylinder cap you should re-zero your pump's pressure transducer. See section 3.5.8. The pump's pressure transducer is a very sensitive strain gage which can be offset as much as 17.2 bar by tightening fittings.

2A.4.3 Back Pressure Regulation

⚠ DANGER

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

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

To install the back pressure regulator

1. Note the arrow on the regulator indicating the fluid direction.
2. Connect your tubing (not supplied) between the pump outlet and the regulator using the supplied fittings, see Figure 2A-10.

Figure 2A-10 Back pressure regulator

2A.5 Nitrogen Purge

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

The 100D or 260D pump is equipped with a purge connector (Figure 2A-11). The purge connector enables the pump cylinder beneath the piston to be purged with nitrogen which inhibits cylinder corrosion and may increase the useful cylinder life. Figure 2A-11 shows a typical purge connection to the purge tube on the back of the pump.

To install the nitrogen (Figure 2A-11*)*

1. Attach gas supply by slipping the plastic tube over the purge connector, see Figure 2A-11.
2. Regulate the nitrogen supply to slightly above atmospheric pressure.

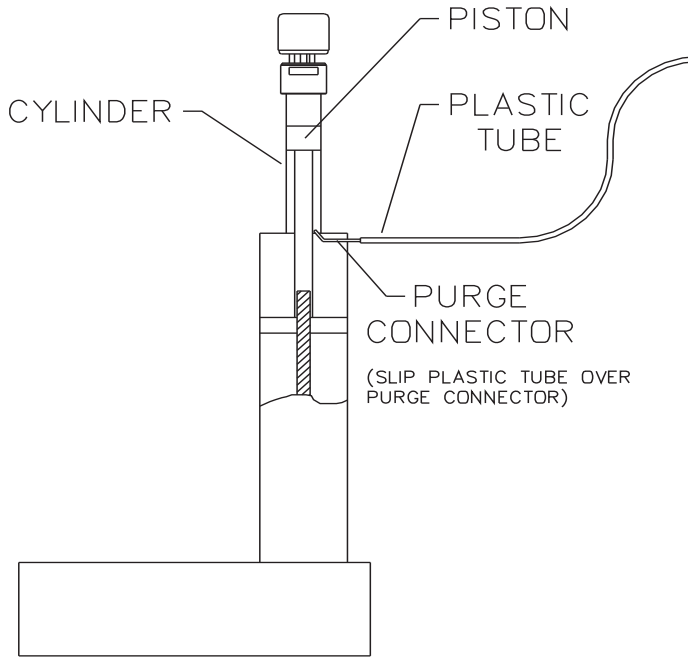


Figure 2A-11 Purge connector installation

2A.6 Optional Kits and Instrumentation

The kits and instrumentation described in this section may be used to enhance the D Series pump operation.

2A.6.1 LabView™ Pump Controller

Teledyne Isco provides a software package which can be used in conjunction with the D Series pump line.

2A.7 Optional Seals

Typically, the general seal provided with your pump will satisfy your application's requirements, including SFE or other applications which use carbon dioxide. However, certain solvents and/or conditions require the cylinder seal be changed to facilitate the application. Table 2A-6 is provided to help you select the correct seal for your pump and application requirements.

Table 2A-6 Seal Selection Chart

Seal Type	Maximum Pressure Rating for Seal (bar)	Seal Description	100DX/DM	260D	500D	1000D
GENERAL/SFE CARBON DIOXIDE	0-689.5 bar	Black, PTFE graphite filled	202-9090-75	202-9091-06	202-9091-56	upper seal 202-9990-25 lower seal 202-9990-23
	This is our standard seal. It is good for most applications, particularly those using organic solvents, such as: LC, SFC, and SFE.					
HIGH TEMPERATURE	0-689.5 bar	Black, PTFE graphite fiber reinforced high temperature compound	202-9090-76	202-9091-09	202-9093-56	upper seal 202-9990-28 lower seal 202-9990-27
	This seal is best suited for applications which require temperatures between 50°C and 100°C. Its chemical compatibility is similar to that of the general seal.					
LOW PRESSURE	0-137.9 bar	Black, PTFE graphite filled single point contact	202-9092-75	202-9092-06	202-9092-56	N/A
	This seal may provide better sealing at lower pressure. Its chemical compatibility is similar to that of the general seal.					
AQUEOUS	0-689.5 bar	White-translucent, ultra-high molecular weight polyethylene	202-9090-77	202-9094-06	202-9094-56	N/A
	This seal has better wetting properties, which makes it a good choice for aqueous solutions. It is also the best choice for electrochemical detection. **Note: This seal requires a special break-in procedure before installation. See Section 5.3.2.**					
AMMONIA (NH3) NITRIC ACID	0-275.8 bar	White, virgin PTFE	202-9090-78	202-9091-07	202-9091-57	upper seal 202-9990-26 lower seal 202-9990-24
	This is the only seal which is recommended for ammonia.					
Note: Call the factory for seal availability for the 65D pump.						

2A.8 Optional Accessories

Table 2A-7 presents the optional accessories available for use with the 100DX/DM and 260D pumps.

Table 2A-7 Optional Accessories

Part Number	Description	
Software		
Call Teledyne Isco	LabView Virtual Instrument Drivers – interfaces D Series Pumps with LabView Software	
Tubing		
004-7300-21	Stainless steel 304 tubing, 1/16" OD × 0.020" ID	
004-7302-22	Stainless steel 304 tubing, 1/8" OD × 0.069" ID	
004-7300-23	Stainless steel 304 tubing, 1/16" OD × 0.007" ID	
004-7601-00	Stainless steel 316 tubing, 1/16" OD × 0.031" ID	
004-7462-51	Stainless steel 316 tubing, 1/16" OD × 0.009" ID	
Extension Cables		
68-1020-210	Pump/Controller extension cable, 3 m.	
68-1020-214	Pump/Controller extension cable, 15 m.	
Inlet/Outlet Fittings		
209-0166-80	1/8" SST plug	
209-0162-00	1/8" - 1/16" tubing reducing union	
In-Line Filter Package (P/N 68-1247-011)		
Qty.	**Part Number**	**Description**
1	60-1243-231	1.5 m - Stainless steel tubing, 1/16" OD × 0.020" ID
1	60-1243-232	0.3 m- Stainless steel tubing, 1/16" OD × 0.020" ID
1	209-9012-17	In-line solvent filter with replacement frit, 0.5 micron filter
5	209-0094-07	Zero volume, 1/16" nut
5	209-0094-08	Zero volume, 1/16" ferrule
Other Accessories		
209-9012-21	5 bar back pressure regulator	
209-9012-22	7 bar back pressure regulator	
68-1247-093	260D High accuracy transducer. Contact factory for specifications.	

Table 2A-7 Optional Accessories (Continued)

Qty.	Part Number	Description
CO_2 Cylinder Connection Package (P/N 68-1247-043)		
1	209-0161-63	Swagelok connector, 1/4" male pipe to 1/8" OD fractional tube
1	209-0161-16	6.35 cm - Nipple, 1/4" pipe thread
1	209-0161-15	Nut
1	209-0161-17	Flat PTFE washer
1	209-0161-64	In-line filter assembly
Manual Outlet Valve Package (P/N 68-1247-078)		
1	209-0098-05	2-way thru valve, 1/8" OD, bracket mounted
1	209-9012-10	10 Micron filter
Appropriate Stainless steel tubing, tube fittings, and unions also included.		
Cylinder Insulating Cover (P/N 68-1247-081)		
Cooling/Heating Jacket Package (P/N 68-1247-047)		
1	60-1248-053	Cooling/heating jacket assembly
1	490-0031-54	3/32" socket screw key
1	60-1242-183	Installation procedure
2	202-2062-23	O-ring, 1.609" ID
SFE Modifier Addition Kit (P/N 68-1247-079)		
2	209-0098-05	2-way thru valve - 1/8" OD
1	60-2253-209	Standard check valve housing
1	60-3864-010	Check valve cartridge
1	60-1243-516	Single check valve housing
Appropriate nuts, ferrules, tubing, and tube fittings also included.		
Manual Pump Refill Kit (P/N 68-1247-077)		
1	60-1243-659	Valve spacer
1	209-0098-05	2-way thru valve, 1/8" OD, bracket mounted
1	023-0504-02	1.5 m - 0.065" ID PTFE tubing
1	60-1243-658	Inlet valve tubing, 1/8" OD
1	209-0161-66	Nut 1/8"
1	209-0161-67	Ferrule 1/8" tubing
1	209-9012-10	10 micron filter
1	60-1243-391	1.5 m coiled - Stainless steel tubing, 0.125" OD × 0.069" ID
Appropriate screws and washers also included.		

Table 2A-7 Optional Accessories (Continued)		
Gradient Mixer Package (P/N 68-1247-080)		
Qty.	**Part Number**	**Description**
2	209-0098-05	2-way thru valve 1/8" OD
2	60-1243-516	Single check valve housing
2	60-3864-010	Check valve cartridge
1	60-1244-245	Check valve stand assembly
1	209-0166-09	3.1 µl static mixer with fittings
Appropriate nuts, ferrules, tubing, and tube fittings also included.		
Continuous Flow Check Valve Package (P/N 68-1247-059)		
4	60-2253-240	Check valve housing, analytical standard inlet
4	60-3864-010	Check valve cartridge
2	60-1243-517	Double check valve housing
Appropriate nuts, ferrules, tubing, tube reducers, and filters also included.		
Continuous Flow Air Driven Valve Package (P/N 68-1247-061)		
2	69-1243-572	3-way valve
1	69-1243-574	Air actuator
Appropriate nuts, ferrules, tubing, tube reducers, and filters also included.		
Analog Output Package (P/N 68-1247-070)		
1	60-1244-262	Analog output circuit board assembly
1	60-1242-277	Assembly instruction procedure
1	232-1140-00	6-32 Stainless steel hex nut
1	149-9004-05	Jack socket assembly

D Series Syringe Pumps: Model 500D

Section 2B 500D Liquid System Connection & Accessories

2B.1 Introduction

⚠ DANGER

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

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

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

☑ *Note*

When operating the pump at flow rates at or below 100 µl/min, it is strongly suggested that a cylinder insulating cover be installed. See section 2B.4.1.

Fluid Connection Accessories (section 2B.3):

Refill kit, 2B.3.1

Temperature and Pressure Controls (section 2B.4):

Cylinder insulating cover, 2B.4.1
Cooling/heating jacket, 2B.4.2

Nitrogen Purge (section 2B.5)

Optional Accessories (section 2B.6):

2B.2 Liquid System Connections

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

2B.2.1 Ports

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

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

⚠ DANGER

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

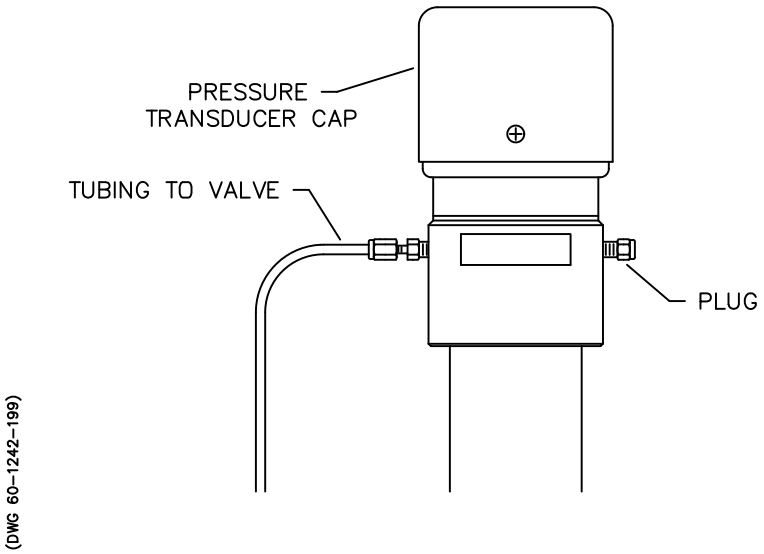


Figure 2B-1 Liquid system plumbing connections for the 500D pump

2B.2.2 500D Installation Tips

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

2B.2.3 Tubing Cutting

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

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

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

To cut the tubing by hand

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

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

2B.2.4 Accessory Package

The 500D accessory package (P/N 60-1249-016) contains the items listed in Table 2B-1. These are included for your convenience, to aid in operation of your pump.

Table 2B-1 500D Accessory Package (P/N 60-1249-016)

Qty.	Part Number	Description
1	202-9091-56	Heavy duty graphite filled seal
1	60-1244-271	Lubrication kit
1	490-0031-25	1⁄8" short arm, socket screw key
1	029-0712-02	0.9 m - 1⁄4" ID Tygon R-1000 tubing

2B.2.5 Drain Tube

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

☑ Note

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

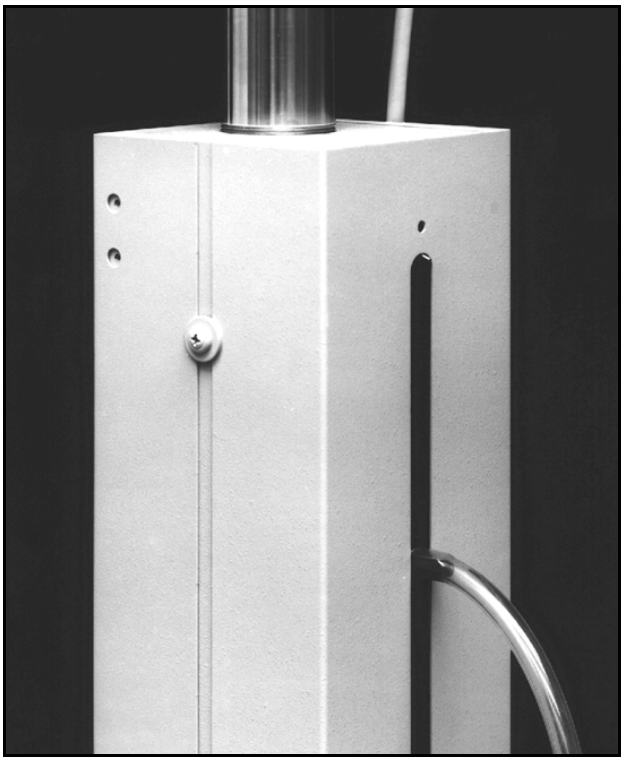


Figure 2B-2 Drain tube installation

2B.3 Fluid Connection Accessories

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

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

2B.3.1 Manual Refill Kit

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

To install the refill kit

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

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

⚠ DANGER

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

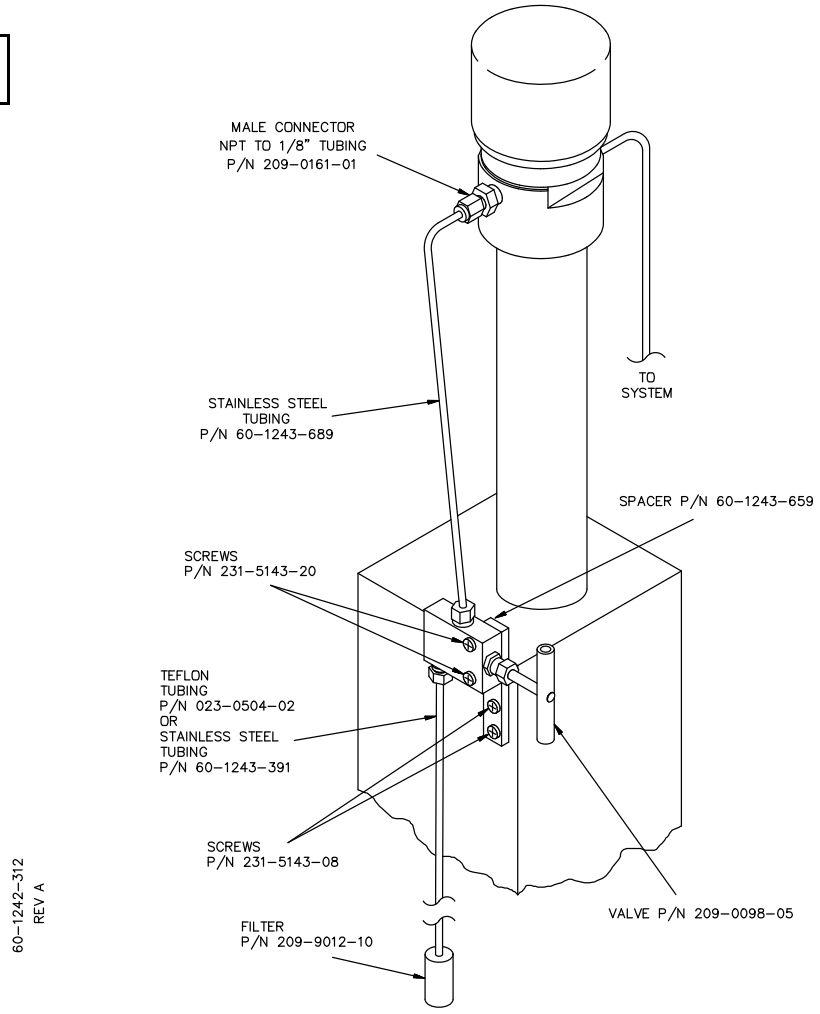


Figure 2B-3 Refill kit installation on the 500D pump

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

   or,

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

2B.3.2 Manual Outlet Valve Package

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

To install outlet valve package

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

⚠ DANGER

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

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

⚠ DANGER

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

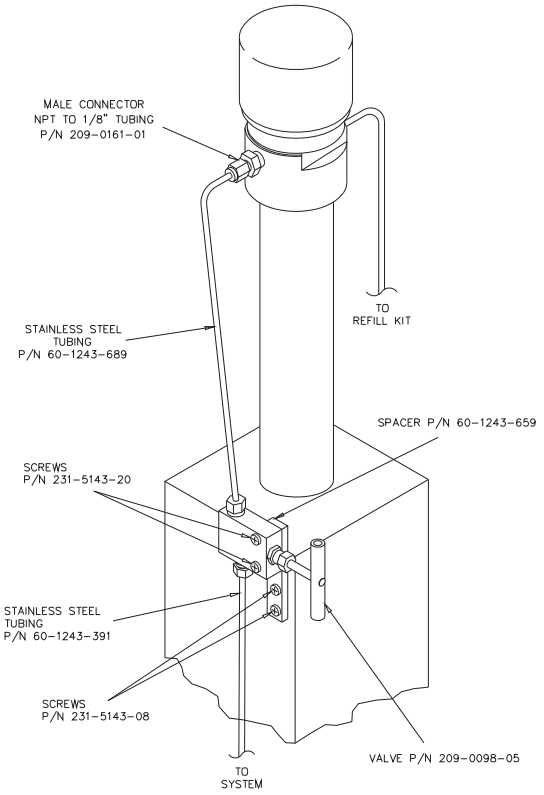


Figure 2B-4 500D pump outlet valve package installation

2B.4 Temperature and Pressure Controls

2B.4.1 Cylinder Insulating Cover

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

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

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

To install the cylinder insulating cover

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

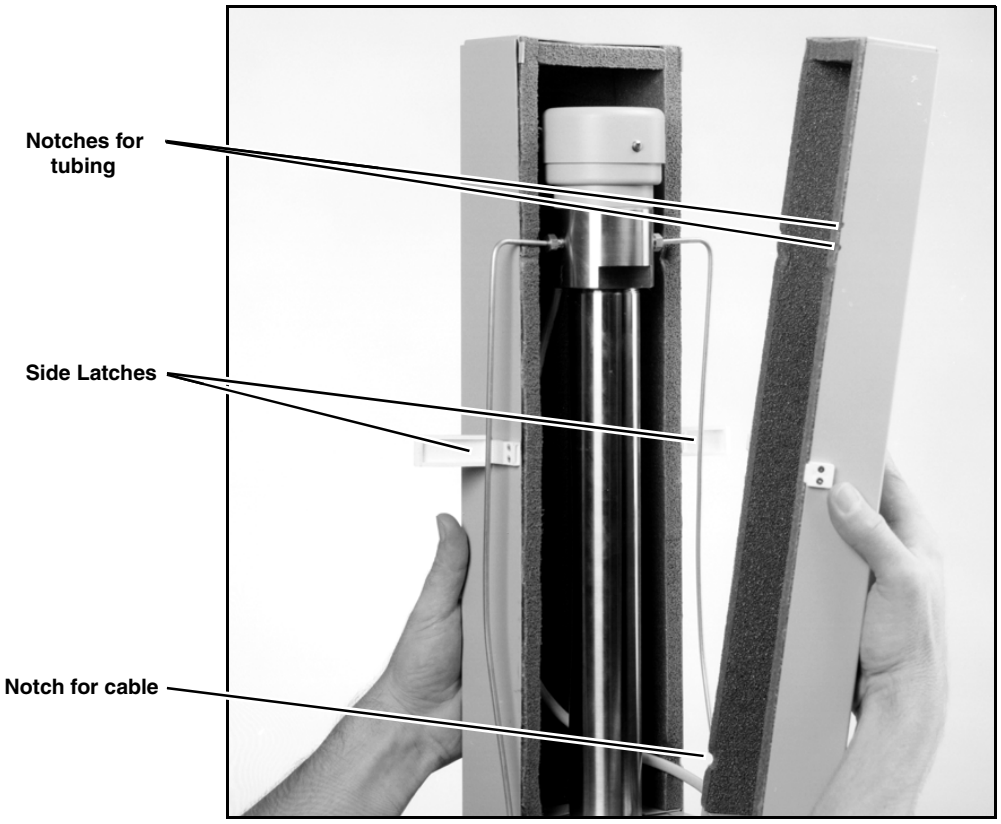


Figure 2B-5 500D cylinder insulation cover

2B.4.2 Cooling/Heating Jacket

An optional cylinder temperature jacket (P/N 68-1247-057) is available for use in maintaining cylinder temperatures (–30 to 100°C) by circulating liquids, such as water or water/ethylene glycol solution, through the hose connectors.

See section 2A.4.2 for installation instructions.

2B.5 Nitrogen Purge

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

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

To install the nitrogen purge

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

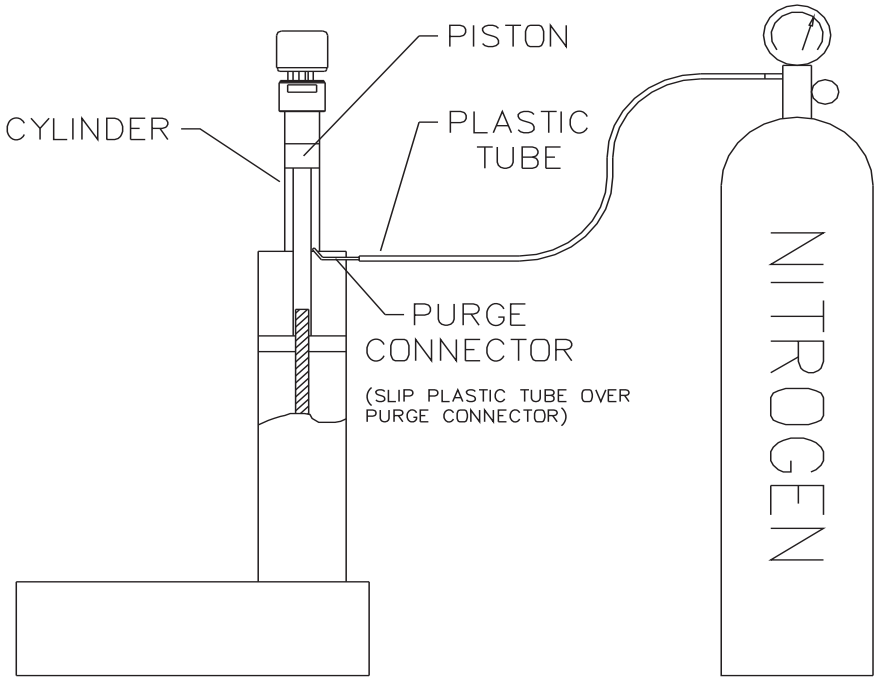


Figure 2B-6 Purge connector installation

2B.6 500D Optional Accessories

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

> ☑ ***Note***
>
> See Table 2A-6 for a list of optional seals.

Table 2B-3 500D Optional Accessories

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

D Series Syringe Pumps: Model 1000D

Section 2C 1000D Liquid System Connection & Accessories

2C.1 Introduction

⚠ DANGER

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

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

2C.2 Liquid System Connections

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

2C.2.1 Ports

There are two ports in the cylinder cap. The 1000D ports come standard with ¼" pipe thread fittings.

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

⚠ DANGER

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

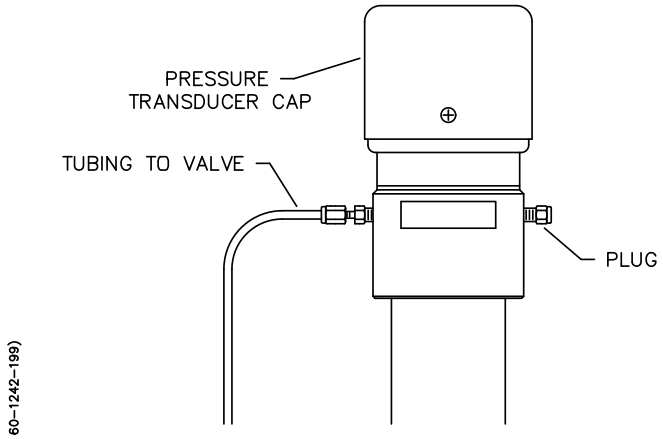


Figure 2C-1 Liquid system plumbing connections for the 1000D pump

2C.2.2 1000D Installation Tips

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

2C.2.3 Tubing Cutting

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

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

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

To cut the tubing by hand

1. Wear goggles. Using a fine jewelers file, score the tubing around its entire circumference.

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

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

2C.2.4 Drain Tube

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

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

Figure 2C-2 Drain tube installation

2C.3 Cylinder Washing and Purging

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

The 1000D pump is equipped for cylinder washing. The two ⅛" tubes located on the back of the pump feed the wash gland.

⚠ CAUTION

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

Typically, a small pump delivers the wash fluid to one of the two $^{1}/_{8}$" tubes. The second tube would then be used as an outlet to drain the wash fluid (refer to Figure 2C-3). Select a wash fluid that will best flush the cylinder of any residue left by the pumped fluid, yet will not damage the seals. If the wash pump is configured to recirculate the wash fluid, ensure that you change the wash fluid at regular intervals.

⚠ CAUTION

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

☑ *Note*

See Page 2A-16 for a list of optional seals.

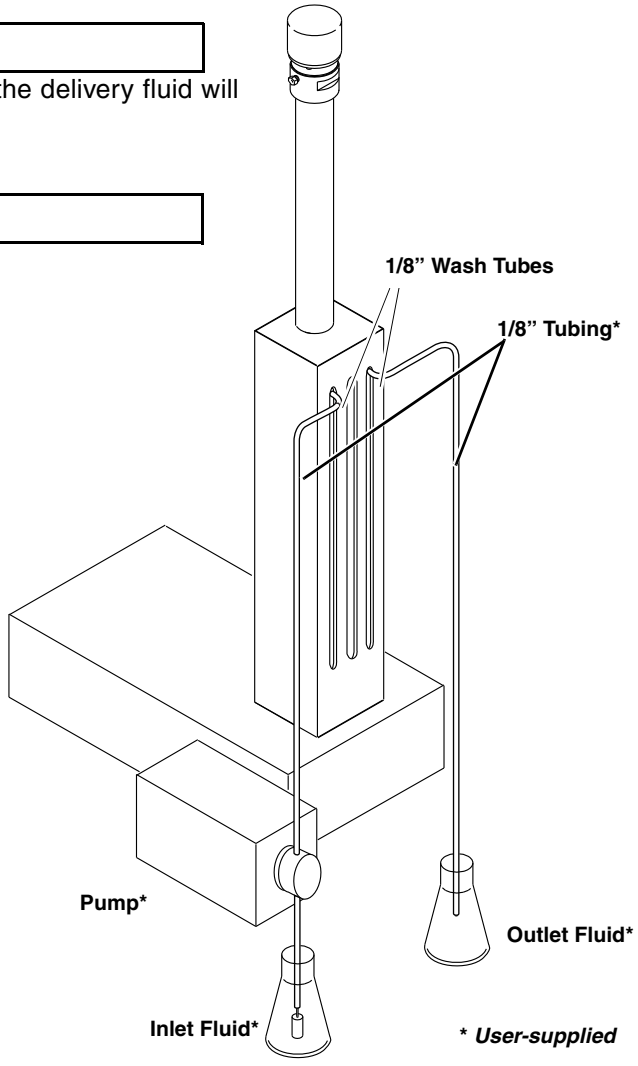


Figure 2C-3 1000D wash fluid connections

D Series Syringe Pumps: Model 65D

Section 2D 65D Liquid System Connections & Accessories

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 1379 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

2D.1 Introduction

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

If you are not familiar with syringe pumps, you may wish to refer to the general information and helpful tips presented in section 2A.2, *Liquid System Connections*. To proceed directly to your package installation instructions, use the following references to locate the desired section.

Fluid Connection Accessories (section 2D.2):

Pump inlet and outlet, 2D.2.1
Drain tube, 2D.2.2

Temperature and Pressure Controls (section 2D.3):

Cylinder insulating cover, 2D.3.1
Cooling jacket package, 2D.3.2

Nitrogen Purge (section 2D.4)

2D.2 Fluid Connections

2D.2.1 Pump Inlet and Outlet

There are two F250C ports in the pump cylinder cap. The F250C fittings are designed for use with high-pressure $^1/_4$"–40 tubing. Either port can serve as the inlet or outlet. As shown in Figure 2D-1, you may plug one port and use a single port as both the inlet and outlet.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 1379 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

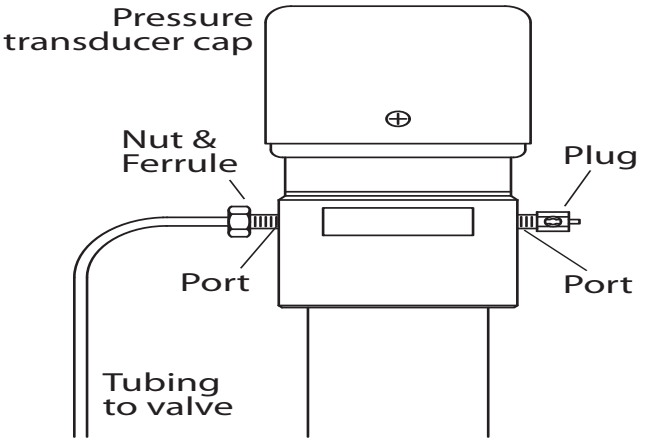


Figure 2D-1 Liquid system plumbing connections

2D.2.2 Drain Tube

The overflow 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 (60-1249-024), to divert the leakage away from the pump. To install the drain tube, simply place one end of the tubing over the end of the drip pan outlet, shown in Figure 2D-2.

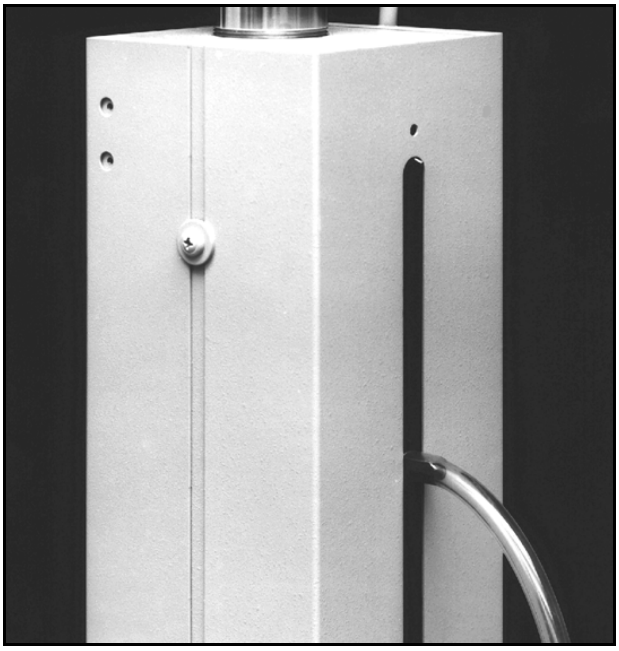


Figure 2D-2 Drain tube installation

2D.3 Temperature and Pressure Controls

2D.3.1 Cylinder Insulating Cover

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

The cover consists of two pieces which fit over the cylinder, as shown in Figure 2D-3.

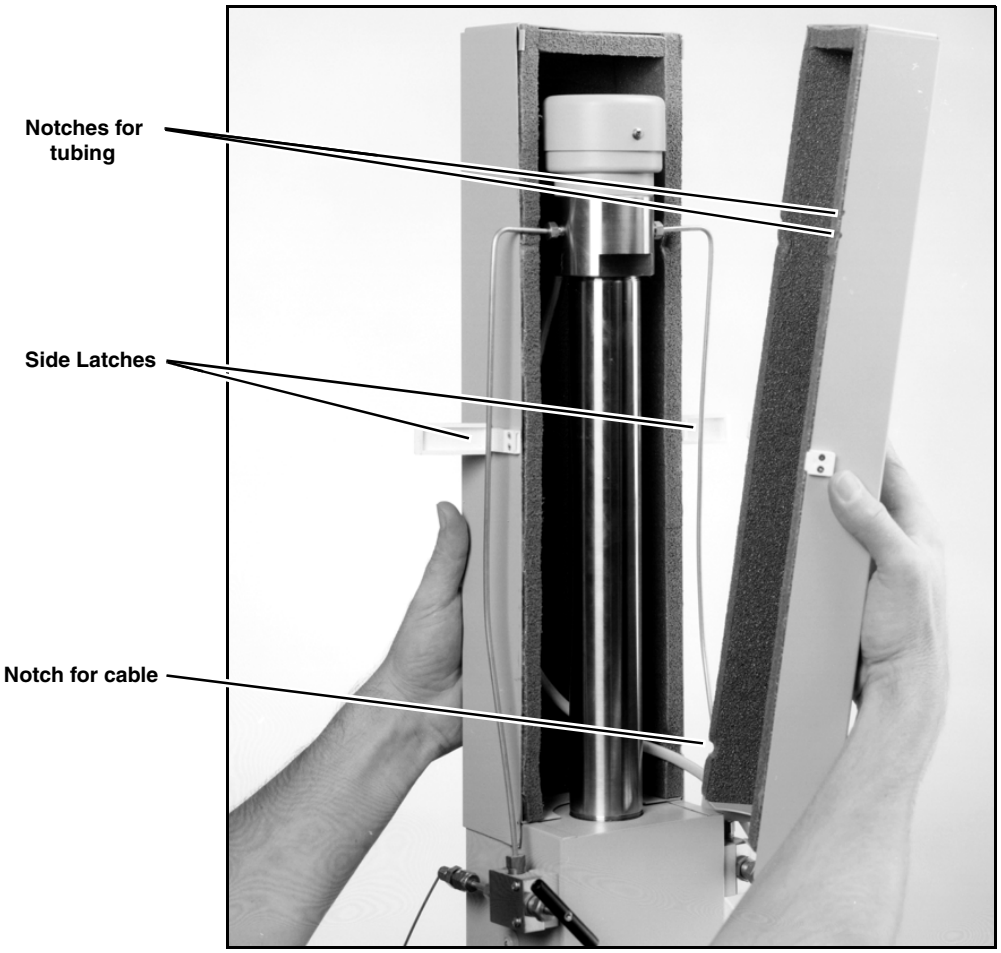


Figure 2D-3 Cylinder insulation cover

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

To install the cylinder insulating cover (Figure 2D-3*)*

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.

2D.3.2 Cooling/Heating Jacket

An optional cylinder temperature jacket (68-1247-047) is available for use 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.

To install the cooling/heating jacket (Figure 2D-4*)*

The jacket is very useful for SFC applications where cylinder cooling facilitates pump 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 100 µl/min), where temperature fluctuation can cause flow variations.

Removing the pump cylinder

1. Empty the cylinder.

☑ Note

Be sure the piston is left fully extended.

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

☑ Note

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

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

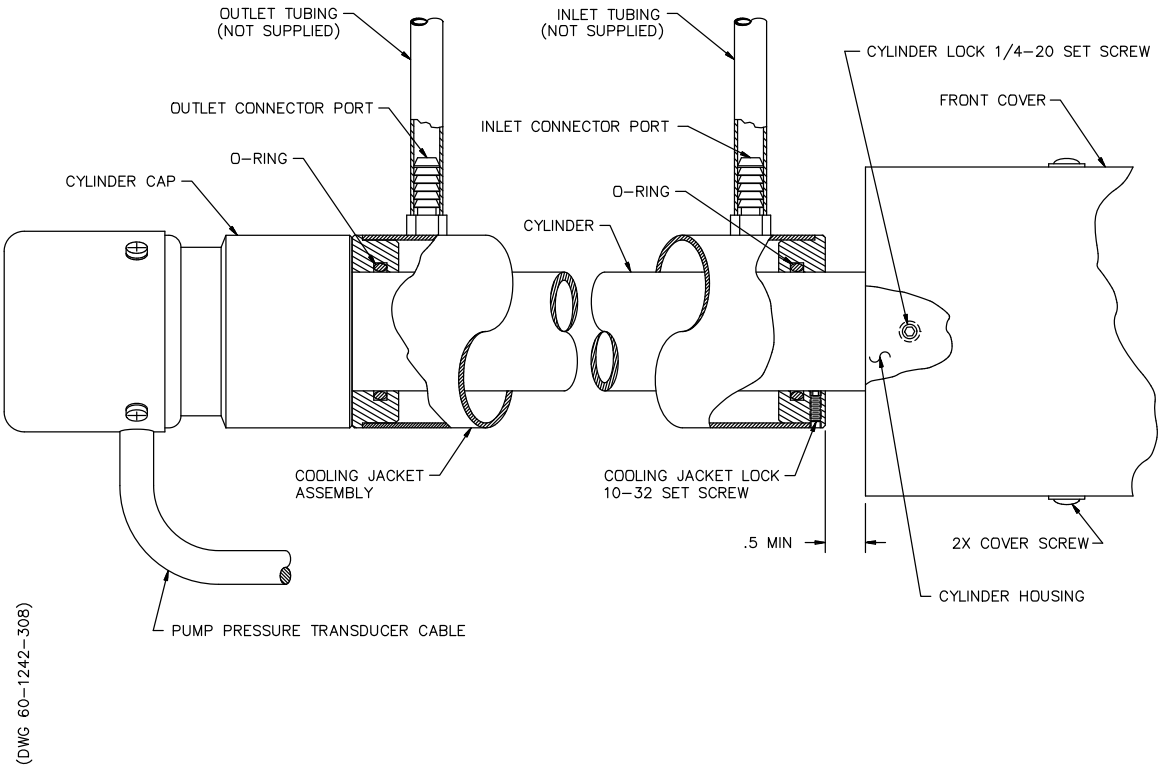


Figure 2D-4 Cooling/Heating jacket installed

Table 2D-1 Cooling/Heating Jacket Package (P/N 68-1247-047)

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

To install the cooling jacket

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

☑ Note

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

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

Reassembling the pump

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

2D.4 Nitrogen Purge

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

The 65D pump is equipped with a purge connector (Figure 2D-5). The purge connector enables the pump cylinder beneath the piston to be purged with nitrogen which inhibits cylinder corrosion and may increase the useful cylinder life. Figure 2D-5 shows a typical purge connection to the purge tube on the back of the pump.

To install the nitrogen (Figure 2D-5*)*

Attach gas supply by slipping the plastic tube over the purge connector, see Figure 2D-5.

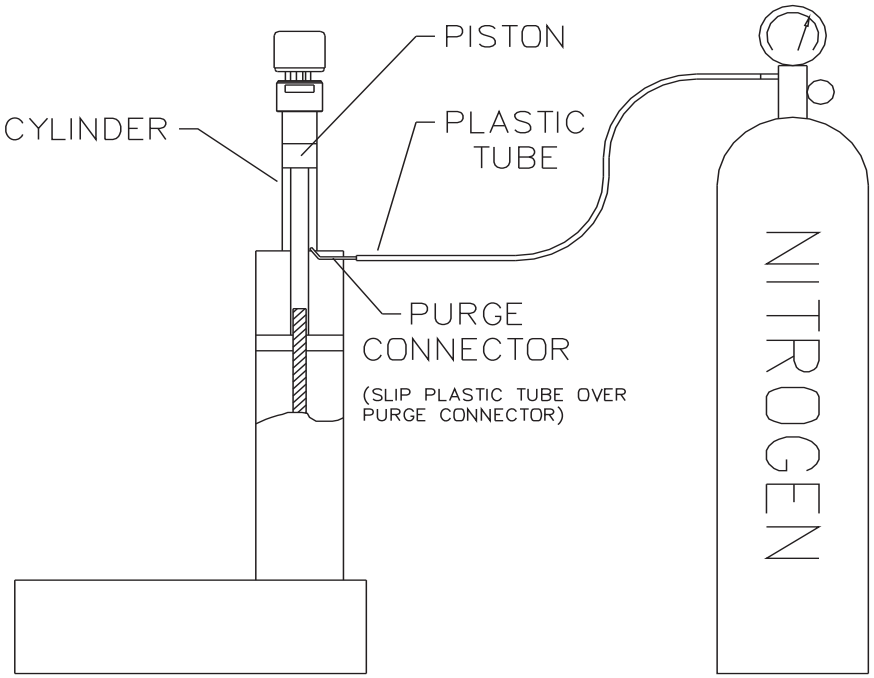


Figure 2D-5 Purge connector installation

2D.5 Flushing the Pump

When changing pumped liquids, flush the pump to prevent cross-contamination or difficulties with incompatible fluids.

In comparison to other D-Series pumps, the 65D has a greater dead volume space due to transducer and tubing differences. This dead volume space increases the possibility of residual liquid being held in the pump.

To flush the pump:

1. Remove the transducer and its tubing from the top of the pump.

⚠ CAUTION

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

2. Using nitrogen, blow out any liquid that remains in the transducer port and tubing.

D Series Syringe Pumps

Section 3 Single & Multiple Independent Pump Operation

3.1 Introduction

This section will familiarize you with the D 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 D Series controller. Operating parameters are entered via the keypad on the front panel of the controller. Operating selections are displayed as menu items on the controller screen or are associated with a dedicated key on the controller keypad. Operating modes such as CONST FLOW, CONST PRESS, and REFILL all have such dedicated keys.

⚠ WARNING

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

3.2 General Controller Information

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

Terminology

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

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

100DX/DM – An abbreviation used when referring to the 100DX and 100DM pumps.

Rates, Units, and Limits

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

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

The system protection limits may also be set by the user, refer to section 3.5.4, LIMITS.

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

3.2.1 Display

There are two types of screen displayed: programming screens and run screens.

Programming screens

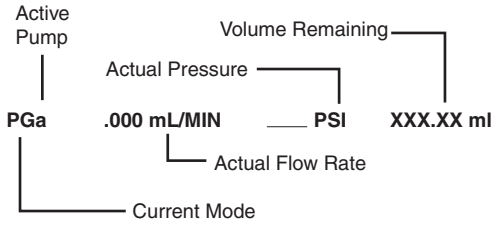
The programming screens are divided into separate menus. These menus are accessed when different features are being programmed.

Run screens

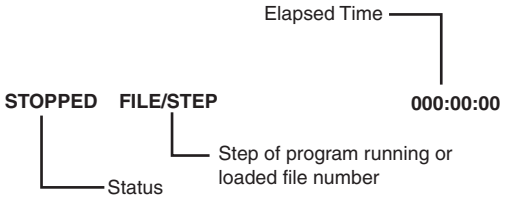
The run screen appears once a program has been loaded and the pump is running.

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

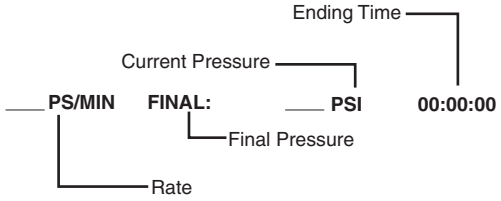
Line One – No matter what mode you are in, the first line of the run screen is always the same.



Line Two – The second line varies slightly depending on the operating mode. 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.

3.2.2 Selecting Operating Parameters

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

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

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

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

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

3.3 Main Menu Features

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

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

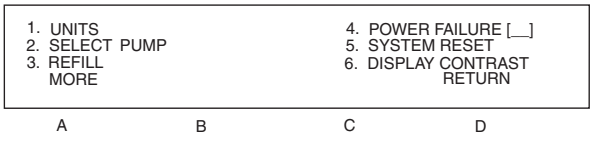


Figure 3-1 Main menu

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

- Units: Section 3.3.1.
- Refill: Section 3.3.2.
- Power failure: Section 3.3.3.
- System reset: Section 3.3.4.
- Display contrast: Section 3.3.5.
- Serial options: Section 3.3.6.
- Status Section: 3.3.7.
- External analog control: Section 3.3.8.
- Multi-pump mode: Section 3.3.9.
- Total volume reset: Section 3.3.10.
- Valve: Section 3.3.11.

3.3.1 Setting Flow and/or Pressure Units

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

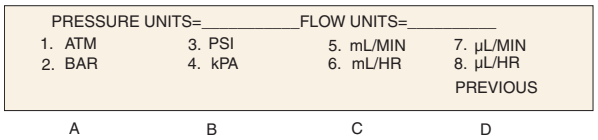


Figure 3-2 Units menu

Setting the units

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

3.3.2 Refill

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

To set auto refill volume

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

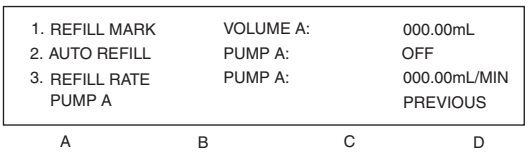


Figure 3-3 Refill menu

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

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

Disable/Enable Auto Refill

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

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

To set refill rate

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

To exit

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

3.3.3 Power Failure [STOP]

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

☑ Note

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

3.3.4 Resetting the System

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

☑ Note

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

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

⚠ CAUTION

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

System reset

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

Hard reset

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

☑ Note

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

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

3.3.5 Display Contrast

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

To change the display contrast

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

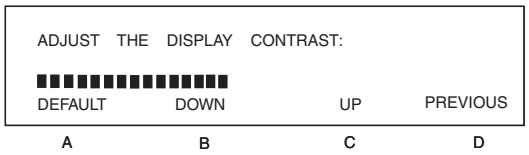


Figure 3-4 Display contrast menu

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

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

3.3.6 Serial Option

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

To change the serial options

1. Press the orange MENU key.
2. Press softkey A, MORE.
3. Press number 1, SERIAL OPTION. The serial option menu, Figure 3-5, will be displayed.

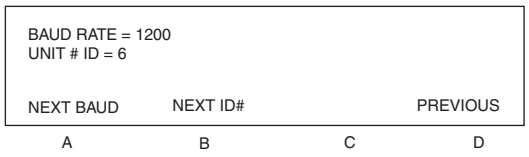


Figure 3-5 Serial option menu

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

For a complete discussion of serial control, refer to Section 6 in this manual.

3.3.7 Pump Status

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

☑ Note

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

To display the status

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

3.3.8 External Analog Control

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

Setting up external control

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

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

   To set parameters for a different pump, press softkey D, SELECT PUMP, and choose A for pump A, B for pump B, etc. Once you have changed pumps, the display will change back to the run screen, automatically.

   If you do not wish to select a different pump, press softkey D to return to the run screen.
2. Press MENU, then softkey A for MORE options.
3. Press number key 3 to select EXTERNAL control.
4. Softkey B will toggle the EXTERNAL mode ON or OFF.
5. If you wish to change the full-scale input voltage, press softkey A to SET RANGE. Then enter the new voltage range between 1.000 V and 11.500 V, and press ENTER to store the value. This voltage will correspond to the maximum flow rate or pressure value programmed by the LIMITS key.

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

where:

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

Pressure Example

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

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

and MAX PRESS should be set to 510.2 ATM.

Maximum Flow Rate Example

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

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

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

Wire Connections

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

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

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

3.3.9 Multi-Pump

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

- Continuous flow in constant flow mode.
- Continuous flow in constant pressure mode.
- Modifier addition in constant pressure mode.
- Modifier addition in continuous flow, constant pressure mode.
- Independent mode.

Continuous Flow (constant flow mode)

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

To connect two D Series pumps for a continuous flow pumping system, you will need a continuous flow check valve package (P/N 68-1247-059) or a continuous flow air driven valve package (P/N 68-1247-129 for 65D, 68-1247-058 for 100D/260D, 68-1247-061 for 500D, or 68-1247-104 for 1000D). Installation and operating instructions for this system are located in Section 8.

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

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

Key	Display Option	Description
A	NORMAL	Uses a finer (slower) pressure match control when switching from one pump to the other.
	FAST	Uses a coarser (faster) pressure match control when switching from one pump to the other.
B	NORMAL PRESS	Uses pressure matching when switching from one pump to the other
	LOW PRESS	Uses no pressure matching when switching from one pump to the other.
C	DELIVER	Sets the pump into the delivery mode of operation.
	RECEIVE	Sets the pump into the receive mode of operation.
6	MIN/MAX POINTS	Sets the fill and refill marks that are used with both continuous flow modes.

Continuous Flow (constant pressure mode)

A D Series continuous flow pumping system in constant pressure mode, will consist of two D Series syringe pumps, and a valve accessory package, all regulated by one controller. To connect two D Series pumps you will need to use a continuous flow check valve package (P/N 68-1247-059) or a continuous flow air driven valve package (P/N 68-1247-058 for 100D/260D, 68-1247-061 for 500D, or 68-1247-104 for 1000D). Consult with the factory when configuring 65D pumps for continuous flow. Installation and operating instructions for this system are located in Section 8.

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

Modifier (constant pressure mode)

A pump modifier system includes two D Series syringe pumps, regulated by one controller and outlet check valves to prevent system back flow into the pump. To connect the 100D/260D pumps, you will need a modifier addition kit (P/N 68-1247-079). Consult with the factory when configuring 65D pumps as a modifier system. Installation and operating instructions for modifier systems are located in Section 9.

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

Independent Control of up to Three Pumps

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

To designate independent control of multiple pumps

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

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

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

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

   When a command such as stop or refill is pressed, a menu will appear asking you to designate the pump to stop or refill. Only the designated pump will stop, the other pumps will continue in the pumping application you have them set for.
6. Return to the run screen by pressing softkey D three times. Then press softkey D (select pump) to display the select pump screen. This screen will show each pump's pertinent information and allow you to select any pump for programming changes.
7. To select B pump from the select pump screen, press softkey B. This will display the B pump run screen. From here, you can start pump B or change the operating parameters.

3.3.10 Total Volume Reset

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

To reset total volume to zero

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

The volume will then be reset to zero.

3.3.11 Valve

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

To select valve type

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

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

3.4 Second Menu

The Second Menu gives you access to various functions. Access the Second Menu by pressing softkey A, MORE, two times.

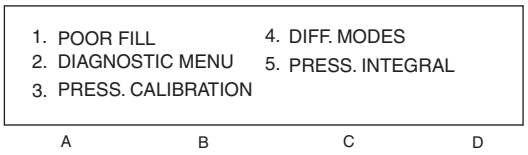


Figure 3-6 Second Menu

3.4.1 Second Menu Menu Options

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

DIAGNOSTIC MENU – Displays an additional menu containing testing options

LCD TEST

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

ANALOG INPUT

This feature will display all the analog input signals on the display.

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

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

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

SERIAL TEST – This feature will test the serial channel. Once this feature is active the software will serial send “*******SERIAL TEST XXXX*********” through the serial port. The “REC.” message will show any serial input characters on the display.

PRESS. CALIBRATION – This feature is used for calibration only. If an incorrect number is entered with this feature, the pumps will **NOT** display/run at the correct pressure. Press “CalA” (“Cal”, “CalC”) and enter the calibration number for the needed pump. Press “Prev” to exit this feature.

DIFF. MODES – The standard pressure transducer **MUST** be connected to pump for correct operation. This feature allows the use of other analog inputs for pressure input to the pump.

Press 1, OFF, to turn off this feature.
Press 2, 0 to 50 ANLG1, to use a 5 volt 50 psi transducer on analog input ANLG1.
Press 3, Custom ANLG1, to use 5 volt custom pressure transducer on analog input ANLG1.
Press 4, 500 ANLG2, to use a 5 volt 500 psi pressure transducer on analog input ANLG2.
Press 5, 5000 ANLG3, to use a 5 volt 5000 psi transducer on analog input ANLG3.

PRESS. INTEGRAL – This feature lets the user turn on/off the integral function for the pump control.

3.5 Front Panel Keys

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

- HOLD, 3.5.1
- RECALL, 3.5.2
- STORE, 3.5.3
- LIMITS, 3.5.4
- RAPID PRESS (Rapid Pressure), 3.5.5
- HELP, 3.5.6
- ACCESS CTRL (Accessories Control), 3.5.7
- ZERO PRESS (Zero Pressure), 3.5.8

HOLD, RECALL, and STORE are all used when in program gradient mode.

3.5.1 HOLD

The HOLD key is used while a gradient is running. When the HOLD key is pressed, this will freeze the program clock and maintain present gradient parameters.

To continue the gradient, press the HOLD or RUN key.

3.5.2 RECALL

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. The RECALL key can be used when the pump(s) are stopped or when in the HOLD mode.

1. Press the RECALL key and use the number keys to enter the number name of the gradient you wish to recall. Press the Enter key.
2. If you enter a number of a gradient which 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.

3.5.3 STORE

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

3.5.4 LIMITS

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

- When using a single controller to operate multiple pumps, you need to select the appropriate pump before setting any pump parameters. The available pumps will be displayed above the softkeys. These selections correspond with the connector that the pump control cable is plugged into on the rear panel of the pump controller. To select a pump, press the softkey under the pump designation. The top line of the screen will indicate the pump which is currently selected.
- The high and low limits you set cannot exceed the pump specifications.

To set the limits

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

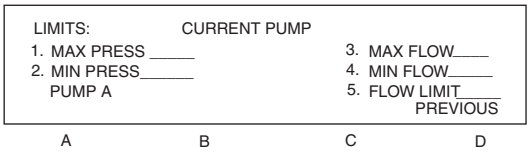


Figure 3-7 Limits menu

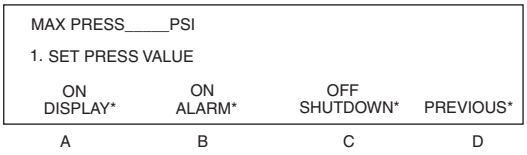


Figure 3-8 Limits setpoint (Max Press) menu

Note

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

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

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

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

Limits programming options

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

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

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

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

Display

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

OFF
DISPLAY

Alarm

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

OFF
ALARM

Shutdown

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

ON
SHUTDOWN

Flow rate limit for pressure control

When the pump is controlling pressure (CONSTANT PRESSURE MODE), the flow rate is not set by the operator, and may range up to the maximum flow the pump is capable of. In some cases, it is desired to limit the rate of pumping during

system pressurization. This can be done by selecting limit 5, FLOW LIMIT. The FLOW LIMIT value is used as the upper range of flow rate during pressure control. This limit is not the same as the MAX FLOW limit which is a threshold above when the pump is stopped, or an alarm is activated as selected by the operator.

To exit

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

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

☑ Note

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

3.5.6 HELP

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

3.5.7 ACC CTRL

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

To set the digital output

1. Press the blue ACC CTRL key. The accessory control menu will be displayed.

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

3.5.8 ZERO PRESS

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

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

   or,

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

3.6 Operating Modes

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

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

CONSTANT FLOW RATE, Refer to Section 3.6.1

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

CONSTANT PRESSURE, Refer to Section 3.6.2

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 7.

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

- Two-pump concentration gradient

- Single-pump linear pressure gradients
- Single-pump flow programs

Refill – Refer to Section 3.3.2.

The user may set the refill rate and change it when in the refill mode.

3.6.1 Constant Flow

To set constant flow operation, use the following procedure:

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

☑ Note

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

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

☑ Note

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

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

3.6.2 Constant Pressure

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

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

☑ Note

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

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

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

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

3.7 External Control

The pump can be externally controlled for pressure or flow rate operation with an analog voltage or through the serial interface. Controlling the pump with an analog voltage is discussed in section 3.3.8.

The serial interface allows you to control the pump operation from an IBM-PC or compatible computer which has an RS-232-C serial output. The serial interface accepts English command words from the computer, like constant pressure, refill, etc. For more information see Section 6, Serial Interface.

3.8 Remote RUN/STOP

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

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

3.8.1 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 or to auxiliary (P11) pin 17.

3.9 Analog Flow Rate and Volume Output Option

The purpose of the analog output option (P/N 68-1247-070) is to provide for analog monitoring of the syringe pump flow rate. If two or less pump modules are connected to the controller, pump volume delivered can also be monitored via the analog output. These outputs are often used with analog based plant or process monitoring equipment.

3.9.1 Compatibility

The hardware for this option includes a rear panel mounted circuit board which is compatible with the D Series 68-1240-026 controller only.

3.9.2 Hardware

Three 12-bit digital-to-analog outputs represent the pump flow rates scaled to the maximum flow rate limits similar to the analog inputs. The three jumper selectable output ranges are 0 to 5V, 0 to 10V, and –5V to 5V. These jumpers are accessed by removing the controller case top. Four outputs are provided on the circuit board and each output can be set to a different range, see Figure 3-9.

The controller is shipped with all jumpers set for the 0 to 10V range. If less than three pumps are connected to the controller, pump volume delivered is provided by the extra outputs. The combinations are shown in Table 3-2.

The MAX FLOW setting accessed via the LIMITS key, sets the fullscale flow rate. (See Section 3.5.4). For example, if the voltage output range is 5 volts and the desired output scale is 1 Volt per 10 ml/min, the MAX FLOW limit should be set to 50 ml/min. The MAX FLOW setting may not exceed the pump specification.

The volume analog outputs are not adjustable. The full-scale range represents one pump stroke. These outputs represent volume delivered, with the maximum output at cylinder empty.

3.9.3 Current Loop Output

The pump controller can be configured to provide a 4–20 mA current loop output. Contact the factory for more information on this option.

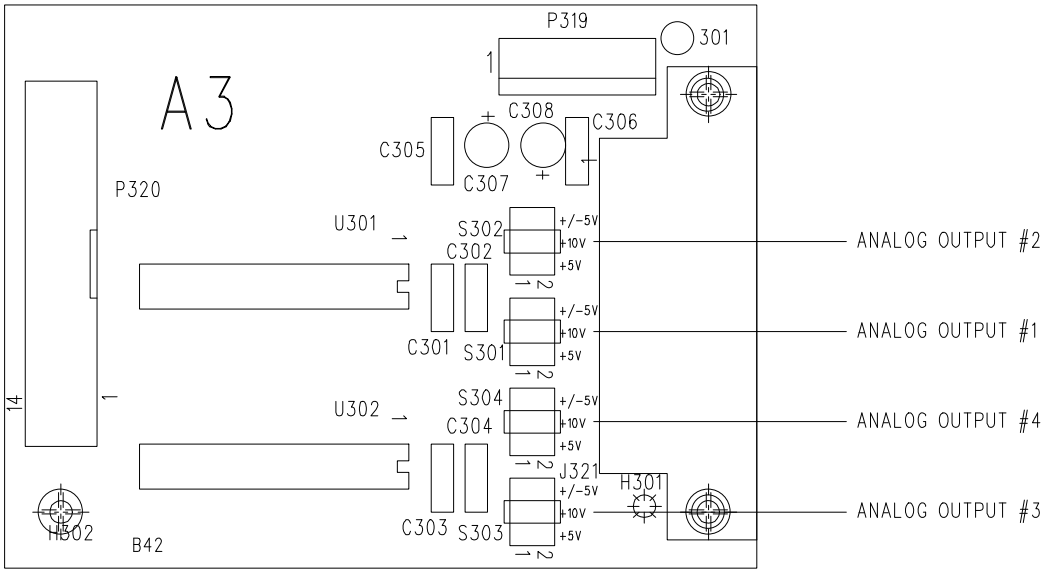


Figure 3-9 Output range selection jumpers

Table 3-2 Analog Output Options (connections to female 25 pin Sub-D)

Pin No.	Description	One or Two Pump Function	Three Pump Function
1	Chassis (earth)	—	—
2	Analog common	—	—
3	Analog common	—	—
4	Analog common	—	—
5	Analog common	—	—
14	Output #1	Flow Rate A	Flow Rate A
15	Output #2	Flow Rate B	Flow Rate B
16	Output #3	Volume A	Flow Rate C
17	Output #4	Volume B	Volume B

D Series Syringe Pumps

Section 4 Theory of Operation

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.

4.1 Introduction

The following sections describe the electrical theory of operation for the D Series syringe pumps and controller. These descriptions are included to aid you in troubleshooting your instrumentation.

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, click **Service & Support**. In the center of the page, click **Fast, thorough factory repair service**. Find the blue heading **Circuit Schematics** and click the indicated link. After you enter your serial number in the field provided, you will be able to view the schematics online. If you need assistance, or don't see the correct schematic for your specific unit, contact our service department.

4.2 Pump Controller

The pump controller is a microprocessor-based user interface and motor control system. The user interface consists of a keypad label; a four-line, 40 character display; and various digital and analog interface connectors, located on the rear panel of the instrument. Up to three syringe pump modules of various capacities can be operated independently or in several coordinated configurations.

Power Supplies

The pump controller, hereinafter referred to as the controller, does not contain a power supply. Each pump connected to the controller contains a power supply but the controller is powered

only by the pump connected to the PUMP A connector on the rear panel. For this reason, care should be taken to remove mains power before connecting or disconnecting the pumps from the rear panel of the controller.

The supplies required are +5 volts for the digital circuitry and ±15 volts for the analog interface circuitry. Other supplies derived from these, using zener diode circuits are ±11 volt supplies for the RS-232 serial interface driver, U107, ±5.2 volt supplies for the analog to digital (A/D) converter, U129, +12 volts for the analog input interface and multiplexer U130, and -3 volts for the analog input interface circuit.

The A/D converter voltage reference VREF, is generated from the +15 volt supply by U133, with R135 as the adjustment. See section 5.11.5 for the adjustment procedure. Battery BT101 maintains the static RAM memory for one month without power to the pump if fully charged. The battery charging circuit uses diodes CR101 and CR102 to direct power to the memory chips U105 and U106 for memory retention and for normal operation (charging). The unregulated supply to the +5 volt regulator in the pump is brought to the controller for the purpose of monitoring the transformer secondary. This voltage labeled +10 volts at TP112, is divided by R120 and R121 and monitored by the internal microprocessor A/D converter. When the supply begins to drop (as in a power failure), the microprocessor detects the drop with enough time to save operating conditions and execute a graceful shutdown.

Microprocessor and Memory

The heart of the controller is the INTEL 80C196 embedded microprocessor U104. The operating code (or firmware) is contained as 16-bit wide information split into two 8-bit EPROMs U102 (low byte) and U103 (high byte). Some static RAM (SRAM) is built into the microprocessor but the bulk is provided by battery backed SRAMs U105 (low byte) and U106 (high byte) also as split 16 bit wide information. The microprocessor bus functions as a zero wait state 16 bit wide bus or as a slower 3 wait state 8- bit wide bus. The selection is under the control of the chip select or address decoding circuit. The wait state generation is internal to the processor. All peripheral chips other than the RAM and ROM, are operated on the slower 8-bit bus, which is buffered through U108, a bi-directional buffer. The microprocessor is designed to address a 64-Kilobyte space. To access more code memory, this system utilizes a paged memory method which allows access to 512 K bytes of code memory (with 27C020s installed), in addition to the 16 K of SRAM. The additional address bits are output through U112, a programmable logic device.

Microprocessor Reset Circuit

The microprocessor reset signal is generated by voltage monitor circuit U101. The microprocessor has an internal pull-up on the active low reset signal. The open drain output at pin 7 pulls the reset signal low when the +5 volt supply drops below about 4.75 volts. Refer to section 5.11.1 for calibration instructions. R108

provides hysteresis to insure the reset signal switches without bouncing. The calibrated switching point is the low to high transition which occurs when the +5 volt supply exceeds 4.875 volts.

The front panel ON/STANDBY switch also exerts control over the reset circuit. In normal operation with the reset signal high, transistor Q101 is turned on. When the front panel switch is changed to STANDBY, it is designed to switch the reset signal low, halting the microprocessor after a delay, sufficient enough to allow saving microprocessor RAM information in the external non-volatile RAM. When pin 3 of P105 switches high, an interrupt routine is activated by pin 15 of U104 which initiates the transfer. With pin 3 of P105 at 5 volts and Q101 turned on, 5 volts is placed across R101. This creates in effect a hardware "request to reset." When pin 3 of U101 goes high, pin 7 will be pulled low activating the reset and turning off Q101. Anything which pulls the reset signal low will release the Q101 "latch" and accomplish this. The microprocessor has the ability to internally pull the reset signal low which is done after all necessary variables have been transferred to the external SRAM and the display has been cleared. The reset signal will then remain low until the front panel switch is set to ON and the +5 volt supply is greater than 4.875 volts. The active low reset signal is inverted by U127 to provide an active high reset signal for U129, U123, and U128.

Keypad Scan Circuit

The front panel keypad is scanned by the microprocessor at a rate of one row per millisecond. Each row of the keypad driver outputs of U128 is sequentially set high, followed by a read of the columns which are normally pulled low by R104. The keypad is debounced by software time delay.

Display

The four line LCD display is connected to the 8-bit wide bus to allow the microprocessor to output display information and read back display status information. Additional control signals are needed for the interface and are provided by U128. The display read/write (D-R/W) signal is active high for a read cycle and low for a write to the display. The display register select (D-RS) controls data flow in the display controller. A read or write is signaled by a momentary low to high pulse on one of the two display enable signals (DISP EN1 and DISP EN2), which control the upper and lower half of the display, respectively. The upper half of the display is decoded in address space as chip select 10 (CS10) and the lower two lines by chip select 11 (CS11).

The display viewing angle adjustment is under software control and may be selected by pressing the MENU key. The adjustment is made by varying the voltage at pin 6 of P104. The HSO.1 pin of the microprocessor outputs a pulse width modulated signal which drives the gate of MOSFET Q103. The resulting pulse signal is filtered by R122 and C139 to drive the display. R123 provides a minimal current to prevent the display from being turned completely off.

Analog-to-Digital Converter Circuit

A 16-bit analog-to-digital converter U129 reads eight multiplexed analog inputs, which include pump pressure signals and general analog interface signals used for external control. The 16 bits of information from U129 is transferred to the CPU in two successive reads. Pin 33 of U129 selects the 8-bit bus mode. The 4051 CMOS multiplexer (U130) input is selected under microprocessor control by setting the three output pins P1.4, P1.5, and P1.6. The 5 volt signal is level translated to 12 volts by U131, a 4504. CR117 protects the circuit from excessive swings and floating inputs. R126 with C144 and C169-C175 filter the inputs to prevent aliasing. The selected input is buffered by operational amplifier U132A. U132B inverts, level shifts, and scales the input signal to match the bipolar input range of A/D circuit U129 determined by voltage reference circuit U133. A circuit composed of diodes and zener diodes prevents this signal from exceeding the analog supplies of U129. The three pump pressure signals are scanned at a rate of 500 HZ, and all other signals at a rate of 100 HZ. These signals are then filtered by software. A conversion is initiated by a low pulse on the HOLD signal (pin 1) of U129, and the end of conversion signal at pin 38 activates an interrupt routine to read the value. These signals should pulse at a frequency of 2.0 kHz.

Motor Control

The syringe pump motor speed control is entirely a digital control system. Both the pressure and flow rate controls are software implemented via the controller module. Feedback and control elements are duplicated for three pump control, so only the pump A controls will be described.

The syringe pump module includes a power amplifier to interface the digital controls to the direct current, brush type electric motor. The pump full and pump empty positions are detected by optoelectronic sensors in the pump module, and the signals connect to P110 of the controller through the pump control cable. These signals are labeled ULA (upper limit pump A) and LLA (lower limit pump A) for cylinder empty and full, respectively. The piston travel limit signals are connected to port 0 of the microprocessor, U104. For more information see section 4.6, Piston Travel Limit Sensors.

The motor drives an optoelectronic quadrature position sensor which encodes the angular position of the motor, see section 4.6, Quadrature Motor Angular Position Sensors. The two quadrature position feedback signals (TACHAA AND TACHAB) connect to P110 via the pump control cable. These signals feed the count inputs of U121, an LS7166 quadrature decoder up/down counter. The value of this counter represents the angular position of the motor. The microprocessor reads U121 via the 8-bit bus and compares this feedback to the desired motor position. A motor drive, pulse-width modulated (PWM) signal and a motor drive, direction signal are then generated by the microprocessor to drive the motor to the correct position.

The direction signals are output through port 1 of the microprocessor (P1.0 for pump A). The pump A PWM signal is output on pin 39 of the microprocessor. The PWM signals for pumps B and C are generated by sections of an 82C54 counter (U113 for pump B and U114 for pump C). The pump control signals are inverted by a 74AC04 which drives the optical isolator LEDs located in the pump module (see section 4.3, Pump Power Supply and Motor Drive Power Amplifier).

Sections of the 82C54 also determine the rate of motor movement. The rate signals return to the microprocessor on pins 24 (pump A), 25 (pump B), and 26 (pump C). If the motor control appears to be functioning properly (holds position) but the motor will not turn, the 82C540s (or their connection to the microprocessor) should be checked.

The motor drive supply voltage is switched between two levels by output pins 18, 19, and 20 of U128 for pumps A, B, and C, respectively. Sections of a 2803 (U126) invert the signals and drive the voltage switching relays. For more information, (See section 4.3) Pump Power Supply and Motor Drive Power Amplifier.

Front Panel Standby Switch

In addition to controlling the microprocessor reset function described under Microprocessor Reset Circuit, one half of the front panel ON/STANDBY DPDT switch is wired in series with the motor enable signal. This signal controls the relay which connects the motor to the motor drive power amplifier.

When the switch is set to the STANDBY position, the motor drive is disabled and the electromechanical brake is applied. The microprocessor can also disable the motor drives of all pumps by turning off transistor Q102 (which is wired in series with the standby switch). Q102 is turned off if a failure of the motor control circuits is detected or if the pump pressure exceeds the pump specification by 103.4 bar. Such failures are indicated on the display by the messages FAILURE POSITION or FAILURE PRESSURE. The front panel switch must be set to STANDBY and then to ON to reset the system. If the condition was transient, the pump may then operate correctly. If there is a permanent failure, the message will repeat.

Serial Port Interface

The hardware interface for the RS-232 serial interface consists of line driver IC U107, a 14C88; and line receiver IC U110, a 14C89.

Accessory Interface

A non-serial digital and analog external interface is implemented on the rear panel ACCESSORY connector. The terminals of this connector are used for various purposes.

Analog Output

The analog output option is described in Section 3.9.

4.2.1 Electric Valve Interface

Incorporated into the Series D Controller is a bus interfaced circuit board for the Electric Valve Package.

Valve Motor Control

The valve is operated by a direct current, permanent-magnetic-field gear motor. The motor provides rotary motion to open and close the valve.

> **☑ Note**
>
> Electric valves are not available for the 65D pump. Please consult the factory for options.

The valve is closed to a preset torque determined by controlling the motor current during the closing cycle. In this type of motor, the output torque is proportional to motor current. Therefore, current control provides satisfactory torque control.

When the valve is opened, the motor rotates a fixed angular amount from the closed position. The motor is operated at a constant speed for the fixed time required to rotate the desired amount.

Circuit Description

(Refer to the Interface Schematic and the Depressurization Valve Schematic.)

Microprocessor Interface

The valve control and sensing signals interface to the controlling microprocessor through U206, an 82C55A integrated circuit. Ports A and C are configured as outputs. Port B is configured as eight inputs. Each output is buffered through a section of a 2803 Darlington transistor driver chip. The outputs of port A select a motor to be operated, select the direction of operation, and switch the power circuitry on or off.

Relays

The motor selection and direction functions are implemented by relays. Six DPDT relays are configured to select the desired motor and an associated current limit setpoint potentiometer. The current setpoint potentiometer is located on the back of the valve motor so that controllers can be exchanged without disturbing the valve torque calibration. A seventh DPDT relay, K204, switches the motor drive polarity, to select the motor drive direction.

Motor Drive Control

A reference voltage circuit provides the setpoint for the current control circuit. Voltage reference U203 is adjusted to 2.50 volts by R212 and is buffered by U202B. The reference voltage is divided to provide the current setpoint signal. R210 and the potentiometer (which is R101 for Depressurization 1 valve) set the maximum current the drive circuit will provide.

Motor current is switched and regulated by FET Q01. Q01 is mounted on the controller rear panel for the purpose of heat dissipation. The motor current also flows through R204, which is in series with Q01. R204 generated the current feedback signal which is a voltage proportional to the motor current.

The current control circuit includes U202A and the associated resistors. They form a linear differential amplifier which is the controlling element in the current control circuit. The circuit subtracts the current feedback signal from the current setpoint signal and amplifies the resulting error signal. The current error signal at pin 1 of U202 drives the gate of Q01 through R207. This prevents the motor current from exceeding the amount set by the current setpoint potentiometer. When the current setpoint is exceeded, the voltage on the drain of Q01 rises. This signals the CPU (via chip U206) to turn off the motor. R205 with C203 connected to the gate of Q01 provide high frequency stability.

To ensure valve opening, the maximum drive current is increased when the valve open direction is selected. The opening current maximum is about 1.5 times the closing current maximum. Q202 is turned on when valve open direction is selected. This places R206 in series with R209. The resulting voltage divider reduces the current feedback signal to 68% of the voltage at R204. The current required to match the feedback signal to the setpoint will be about 1.5 times greater than with Q202 off.

Standby

One section of the 2803 is used to insure that the motor drive is turned off when the microprocessor is not operating. The STANDBY signal from the front panel switch turns the open collector 2803 off when the switch is set to RUN. When the switch is set to STANDBY, R214 turns the 2803 on. The output pulls the gate of Q1 low, which turns the motor drive off, regardless of the state of the 82C55 output.

Circuit Failure Detection

U202C functions as a comparator to monitor the motor drive current. The threshold is set at 1.14 amps. This current value should never be exceeded in normal operation. If a failure occurs in the current control circuit, which results in excess current, the output (pin 8) of U202C will go high. This signal will be read by the microprocessor and the user will be notified of the failure.

4.3 Pump Power Supply and Motor Drive Power amplifier

The motor drive circuit, located in the pump module on the pump power circuit board, consists of an input signal isolation circuit, a current limiting control circuit, and a power amplifier circuit. An LC filter, which converts the pulse-width modulated (PWM) power signal to a DC motor drive voltage, is located near the motor off the circuit board.

The PWM signal and the direction signal from the controller are buffered by U102, a high speed optocoupler circuit. The outputs at pins 6 and 7 are active high when the respective inputs are flowing current (controller outputs low).

The two control signals then pass through the current limiting and direction steering circuit. The PWM signal (labeled PULSE) is gated by U102C to turn off when the motor drive current exceeds 5 amps. R104 with R105 divide the +12 volt supply to provide a 0.5 volt reference. Comparators U101A and U101B compare the reference to the voltage across 0.1 ohm current sense resistors R112 and R116 respectively. R116 senses the

current when power is applied to the motor in the forward (piston up) direction. R112 senses current with power applied in the reverse (piston down) direction. U103B and U103C are connected to form an RS flip flop which is set at the beginning of a PWM cycle and is cleared if the motor current exceeds the 5 amp limit.

When the PULSE signal goes high, current will flow through the motor and increase with time. If the current exceeds 5 amps before the end of the PWM cycle, the comparator will reset the flip flop. U104C gates the PULSE signal through, according to the state of the RS flip flop, which disables the signal when a current limit has been reached. The PULSE signal is then steered to the correct drive transistor, according to the DIRECTION signal.

Transistors Q106, Q107, Q108, and Q109 form an H bridge power amplifier. N channel power FETs, Q106 and Q108, form the lower half of the bridge; P channel power FETs, Q107 and Q109, form the top half. In addition to the pulse-by-pulse current limiting for the N channel drivers, the P channel FETs are protected by a current limiting circuit. Considering Q107 as an example, the gate voltage is supplied by level shifting transistor Q102. Q102 is connected so that it places a constant voltage (about 10 volts) across R109 when turned on, resulting in a constant current through the collector. This current, which also flows through R111 and regulating diode CR103, applies 12 volts to the gate of Q107, which turns it on. Filter C127 prevents switching noise from turning on Q107.

Current sense resistor R113 applies a voltage to current limiting transistor Q103. If the voltage reaches the base-emitter band gap voltage of about 0.6 volts, Q103 will turn on, reducing the gate voltage of Q107 and regulating the current through Q107 at about 6 amps. This usually occurs only in a motor braking situation where the braking current would circulate through the top half of the bridge, unaffected by the pulse-by-pulse current limiting. The P-channel transistors are not pulsed when the lower half transistors are switched by the PWM signal, but remain turned on when the associated N-channel transistor is being modulated.

Q107 (up supply) is turned on when Q108 (up gnd) is being pulsed to drive the piston up. Q109 (down supply) and Q106 are used in the same way to drive the piston down. The direction of drive is not necessarily the direction of piston travel. For example, if the piston is traveling up (delivering fluid) and the STOP key is pressed, the motor will be braked by reversing the direction of drive. This bi-directional control, which allows for quick reversal of piston travel, is necessary for pressure control.

In addition to the direction control logic located on the pump power circuit board, some logic is implemented via the software. If the motor is reversed while turning at high speed, the back EMF will be high enough to cause a current to circulate through the top half of the H-bridge, sufficient to activate the 6 amp current limit. If this occurs and is allowed to continue, the voltage across the P-channel transistor will increase to a level

high enough for the power dissipated by the transistor to destroy the device. To protect the high side drivers in this braking condition, control software pulses the direction signal. This allows the current to alternately build up to a safe level and decay between pulses, limiting the power dissipation of the device.

Below approximately 800 RPM of the motor, the direction signal functions without this pulsing effect and correctly indicates the desired direction of motor drive.

Pump Type	Flow Rate at 800 rpm
1000D	40.582 ml/min
500D	20.295 ml/min
260D	10.642 ml/min
100DM	3.0888 ml/min
100DX	6.1776 ml/min
65D/DM	2.7176 ml/min

Referring to the components connected to the gate of Q106, two additional circuit functions are present. Negative feedback compensation is provided by R137 in series with C130. They limit the switching speed of Q106 and prevent oscillation. A current-limiting circuit, consisting of Q111, R112, and R139, limits the current through Q106 to about 6 amps by reducing the gate drive voltage in the same manner described previously for Q107, R113, and Q103. In normal operation, when Q106 or Q108 are switched off, energy stored by the motor inductance and filter inductors (L1 and L2) may maintain current flow until the next drive pulse. If current is circulating in this manner through diode CR105 when Q106 is switched on, there will be a short delay after current reversal before CR105 turns off.

Q111 limits the current from the supply (+VM) through CR105 and Q106 while CR105 is in the low impedance state.

Inductors L1 and L2 with capacitor C1, form a low pass LC filter between the power amplifier and the motor. Capacitors C2, C3, and C4 attenuate motor brush electrical noise. Relay K101 is switched by the controller and serves to connect the motor to the power amplifier when energized. When released, it connects R115 across the motor terminals to dissipate energy and brake the motor. An electromechanical brake (shown electrically as L3) is wired in parallel with K101 to allow the pump to hold pressure without motor rotation when the power amplifier is disconnected or the instrument is without power.

To activate the relay and release the brake, the motor enable signal must be pulled low by the controller. This signal is series-wired through the controller front panel ON/STANDBY switch and a transistor switch under control of the microprocessor. This allows both the operator and the microprocessor to disable the motor if either detects a problem.

The motor supply voltage +VM is switchable between two levels under control of the microprocessor. To allow a greater motor speed dynamic range, the motor supply voltage is switched to better match the motor operating speed. Motor voltage select relay K102 switches the power rectifier between a half bridge and full-bridge configuration to provide two voltage selections which differ by a factor of two. The relay is switched to the full bridge configuration above 3000 RPM. In constant pressure mode, K102 is left in the full-bridge (high voltage) setting at all speeds. The motor drive circuit is somewhat electrically isolated from the rest of the instrument, except for R123, a 47k ohm resistor between motor common and earth ground. The +12-volt supply for the power amplifier logic is referenced to the motor common rather than instrument common. This supply is generated by a voltage regulator circuit drawing its supply from the motor supply voltage. Zener diode CR102 with diode CR101 and R114 provide the reference base drive voltage for Q101 which is configured in the emitter-follower configuration. Q101 thus acts as a current amplifier at 12-volts fixed output.

The remaining transformer windings supply power for + and -15-volt, 5% regulators and an adjustable 5-volt supply. Since the 5-volt supply is used as a reference by the microprocessor A/D converter, it is adjusted to a tighter tolerance than the 15-volt supplies.

4.4 Pressure Transducer and Amplifier

To sense cylinder pressure there is a strain gauge built into the cylinder cap. The strain gauge is a 120 ohm bridge with a sensitivity that relates to the pressure. The table below lists the approximate sensitivity of each pump model. The strain gauge is connected to a -5.00 volt reference supply (CR51 and U51B), a preamplifier (U52), and a final amplifier (U51A), all located on a circuit board enclosed at the top of the cylinder.

Pump Model	Approximate Sensitivity
1000D	100mV/137.89 bar
500D	100mV/344.8 bar
65DM, 100DM/DX, 260D	100mV/689.5 bar
65D	100mV/1379 bar

The pressure amplifier gain is adjusted by R53 to provide a signal of 2-volts per 68.95 bar for the 500D, or 1-volt per 68.95 bar for the 65DM, 100DM/DX, and 260D, and 0.5 volt per 68.95 bar for the 65D. This pressure signal is used for the pressure display, pressure limiting, and as feedback for constant pressure regulation. Analog pressure output jacks are located on the rear panel of the pump module. The two outputs are scaled for ranges of 1.0-volts per 68.95 bar and 0.10-volts per 68.95 bar. These outputs are not adjusted by the automatic pressure zero software which affects the pressure display and control at the controller. For this reason, these outputs will disagree with the controller display by the amount of the offset.

4.5 Automatic Pump Type Indication

U108 automatically indicates to the microprocessor which pump type is connected to a given port. In addition, when the pressure transducer is connected, the signal labeled PC-1 (pump code 1) is grounded at the pressure amplifier circuit board. This indicates its presence to the controller. The pump will not operate without the pressure transducer connected.

4.6 Optical Indicators Piston Travel Limit Sensors

An optically coupled interruptible sensor is mounted at each limit of piston travel. A mechanical flag blocks the light path of a sensor when the piston is at the cylinder full or cylinder empty position. The optotransistors are connected to pull the limit signals high when the light path is open (transistor on). When the light is blocked, resistors R125 or R126 pull the signal low. Additional pull down resistors are located in parallel on the control circuit board. With this connection, the most common failures of the optodevice (such as a failed LED or a nonconducting transistor) will stop the pump with an indication of cylinder full or empty. The LEDs are wired in series so that an open circuit of either will stop the pump.

The limit sensors also disable the motor drive through opto-couplers U105 and U106 when a limit is reached. The circuit remains enabled, to drive the piston away from the limit.

Quadrature Motor Angular Position Sensors

Motor position feedback to the microprocessor is generated by two optically interrupted sensors which span a rotating etched metal disk. This sensor is an enclosed sensor: HEDS-5500 II A06 (500 line) for the 1000D and 65D; HEDS-5500 II E06 (200 line) for all other pump types. Two rows of slots in the disk are arranged in quadrature (or 90 electrical degrees out of phase) with respect to each other. When the motor is rotating in the direction which moves the piston up, the TACHA signal leads the TACHB signal. The order reverses in the opposite direction of rotation. The light sensors are integrated circuits which use a photodiode, followed by amplification circuitry which drives the output high when light from the LED passes through the disk slots, and low when the light is interrupted.

The +5-volt power supply for all optical sensors originates at the pump, but is first passed to the controller and back to the pump to insure that the sensors do not apply input signals to the controller logic without the logic +5-volt supply present. This is necessary because when multiple pump modules are connected to the same controller; the B and C pumps (which do not power the controller) may be connected to mains power without the A pump powered. Therefore, all optical sensors in a multiple pump system are powered from the pump A power supply.

D Series Syringe Pumps

Section 5 Pump Maintenance & Repair

DANGER

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

DANGER

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

WARNING

Earth ground bonding conductor. Do not remove or disconnect.

Mise à la terre. Ne pas enlever ni déconnecter.

WARNING

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

5.1 Introduction

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

To view the 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, click **Service & Support**. In the center of the page, click **Fast, thorough factory repair service**. Find the blue heading **Circuit Schematics** and click the indicated link. After you enter your serial number in the field

provided, you will be able to view the schematics online. If you need assistance, or don't see the correct schematic for your specific unit, contact our service department.

5.1.1 Service Department

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

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

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

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

5.1.2 How to Ship Returns

In the rare event that an instrument must be returned for maintenance, be sure all parts and hardware are back in place before packing. The pump should not be shipped unless the piston and cylinder have been rinsed with methanol or isopropanol (to prevent freezing). Wrap the unit in heavy paper or put it in 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 (shredded paper, bubble pack, expanded foam chunks, etc.). Seal it with strapping tape or gummed cloth tape and ship it to the address listed on the warranty. The warranty at the end of the manual also describes the conditions under which Teledyne Isco will pay surface shipping costs.

NOTICE

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.

☑ Note

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

5.1.3 Removing the Case Top

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

⚠ DANGER

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

⚠ DANGER

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

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

5.2 Lubrication

☑ Note

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

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

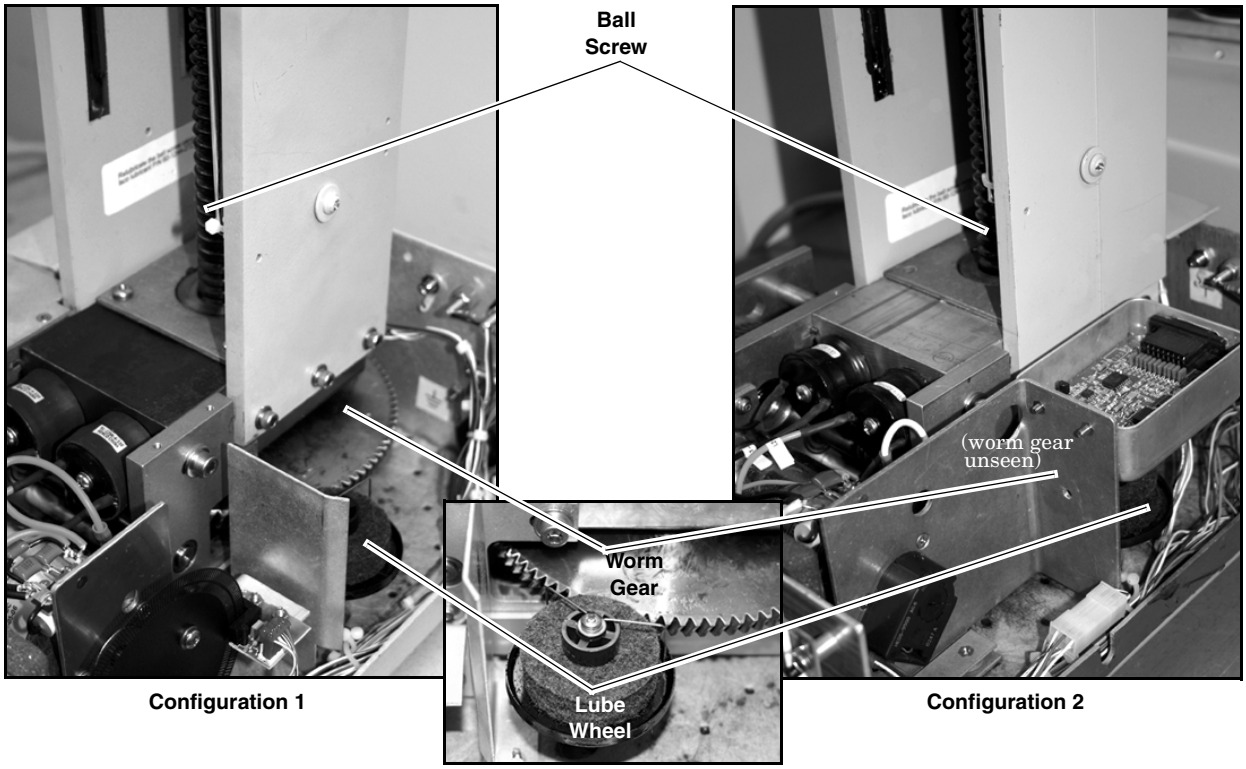


Figure 5-1 Gear train lubrication and motor drive service

Worm / Worm Gear

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

☑ Note

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

5.2.1 Ball Nut

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

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

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

Precision Thrust Bearing

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

5.3 Seal Cleaning and Replacement

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

1. Run the pump at maximum flow rate until it's empty.
2. Disconnect the power cord.
3. Disconnect the pump pressure transducer cable from the controller and remove the tubing from the inlet and outlet ports.
4. Remove the front cover of the pump.
5. Loosen the four cover screws.
6. Then loosen the cylinder lock screw which is a ¼-20 setscrew located in the front side of the cylinder mounting block.
7. You may now unscrew the cylinder. If you need to use a wrench, we recommend using a strap wrench or the wrenches in the Teledyne Isco wrench package (60-1247-067 for 65DM, 100DM, 100DX, and 260D; 68-1247-068 for 500D; 60-1247-093 for 1000D), which will not mar the cylinder's outer surface.
8. Once the cylinder has been unscrewed, lift it up and off the piston and the push tube.

5.3.1 The Piston Seal

Sometimes dirt or other solids on the seal can cause leakage. Removing and cleaning the seal may stop the leak and a new seal may not have to be used. However, if you remove and inspect the seal and it does not have any obvious crease or you did not find any foreign material on the seal, then the seal must be replaced. Check the wear ring. See Section 5.4.

☑ Note

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

☑ Note

If your pump uses polyethylene piston seals, be sure to follow the special instruction below for this type of seal.

Accessing the Piston Seal

1. Unscrew the piston seal retainer (Figure 5-2) from the piston and remove the seal from it. Notice that the spring imbedded in the seal is facing up or is on the top side of the seal.
2. Clean both the piston seal retainer and the cylinder thoroughly. Make sure all parts that come into contact with the seal are free of dirt and other solids.

3. Once the seal and cylinder surfaces have been cleaned, rinse both parts with isopropyl alcohol.

5.3.2 Piston Seal Break-In (Aqueous seals only)

The break-in procedure is intended only for the UHMWP (aqueous) piston seal, to prevent the spring from bowing out its shape.

1. Assemble the piston assembly per Figure 5-2A. Be sure to install the top seal on the piston with the spring facing down.
2. Slide the cylinder over the piston assembly, per Figure 5-2B, and allow it to sit for 15 minutes. This "breaks in" the seal for the steps that follow.
3. Remove the cylinder.
4. Reassemble the top seal with the spring facing up, per Figure 5-2C.
5. Install the cylinder over the piston assembly, again, and screw onto the mounting block.
6. Leak test the pump.

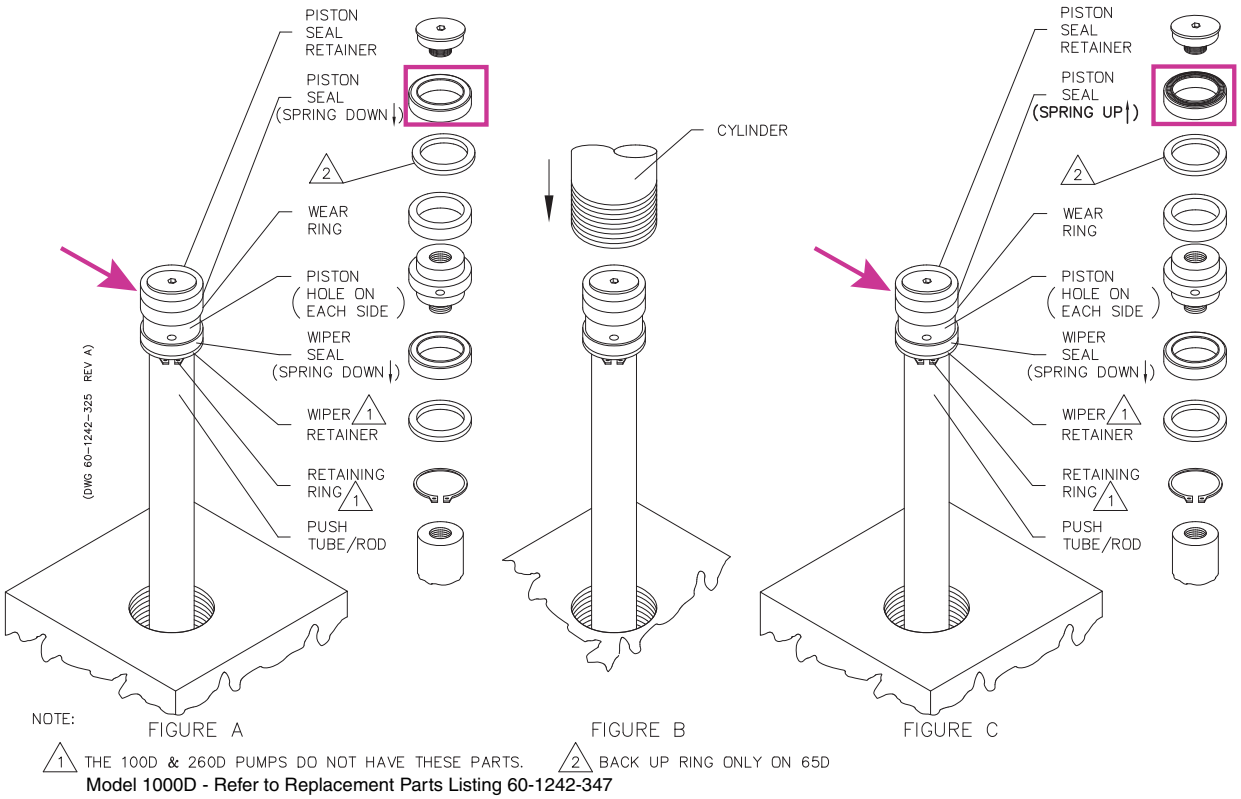


Figure 5-2 Break-in procedure for aqueous seals

5.3.3 All other piston seals

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

5.3.4 The Wiper Seal

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

1. Access the cylinder as described previously.
2. Locate the piston (Figure 5-2).
3. Insert a round, $\frac{1}{8}$" diameter steel bar or tool of some sort into the round hole on the side of the piston.
4. Use the tool to twist the piston loose, then unscrew it by hand.
5. Remove the retaining ring and wiper retainer, then lift off the wiper seal. Being careful not to scratch any sealing surfaces, gently break free any solids from the seal and piston. Rinse all the solids away with distilled water.

5.3.5 To reinstall the wiper

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

5.4 Wear Ring Cleaning and Replacement

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

To replace the wear ring

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

The wear ring prevents the piston from direct metal-to-metal contact with the cylinder wall, and should, therefore, extend at least 0.010" beyond the circumference of the piston lip. Check the bottom of the wear ring, which rests on the piston lip, for extrusion or any unevenness. If there is an indentation (of

0.0010" or more) marking the outline of the piston lip, then you should replace the wear ring. However, if the surface is smooth, the wear ring does not need replacing.

5.5 Flushing the Cylinder

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

The way in which the cylinder is flushed will depend on your pumping system and whether you are pumping a liquefied gas such as CO_2 (see Section 5.5.1) or a liquid modifier such as methanol (see Section 5.5.2).

5.5.1 Gas Solvent Changeover

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

To switch gas solvents

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

5.5.2 Liquid Solvent Changeover and Flushing

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

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

To clean the cylinder

1. Press the CONST FLOW key on the front panel of the controller.
2. Press the RUN key. You will be asked to designate which pump if more than one is present.
3. Press a softkey to run the desired pump.
4. Run the pump until the message “CYLINDER EMPTY” is displayed.
5. Place the pump inlet line in a flask containing a compatible solvent or a detergent solution.
6. Press the blue REFILL key.

7. You will be asked to designate the pump to refill if more than one is present. Press a softkey to refill the pump.
8. Fill the pump and repeat this procedure several times.
9. Then place the pump inlet line in a flask containing distilled water or appropriate solvent. Fill the pump once more and then run it until empty. You are now ready to fill the pump with your new liquid solvent.

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

5.6 General Cleaning

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

5.7 Torque Limiter

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

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

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

5.8 Shear Key Replacement

Table 5-1 below provides part numbers for each pump model replacement shear key.

Table 5-1 Replacement Shear Keys

Pump Model	Part Number
1000D, 500HP, 260D, 65D	60-1243-607
500D	60-1243-654
100DM/DX	60-1243-608
65DM	60-1243-949

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

☑ *Note*

The 65DM pump has a bearing set not included in the other pumps. In addition to following the other steps in this section, when performing shear key replacement on a 65DM pump, ensure that the bearing set is properly reinstalled, as described in Section 5.8.3.

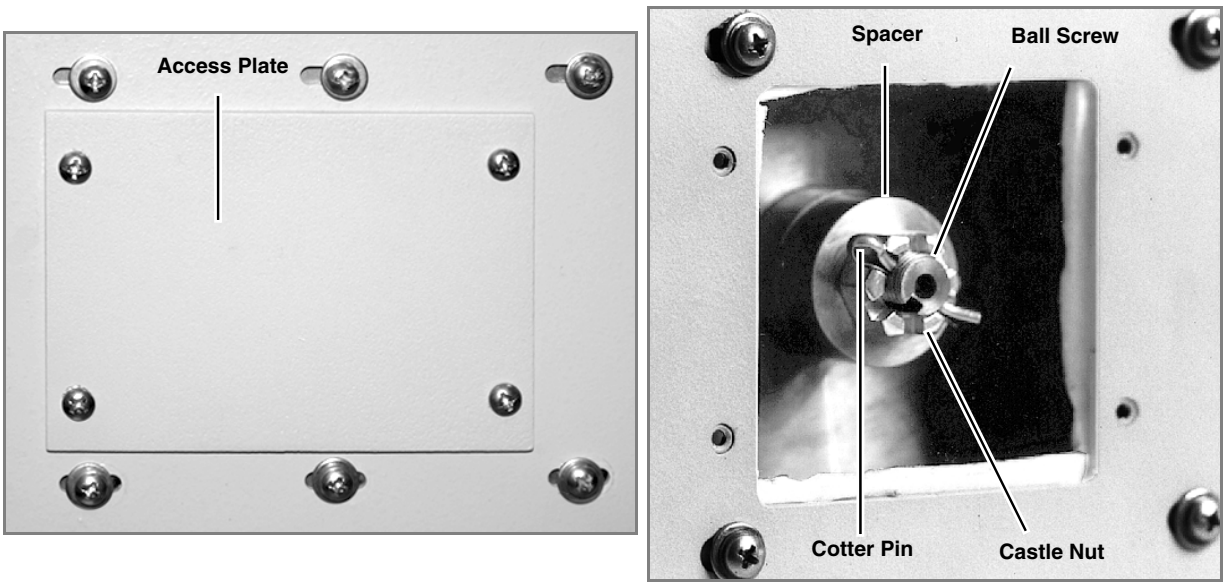
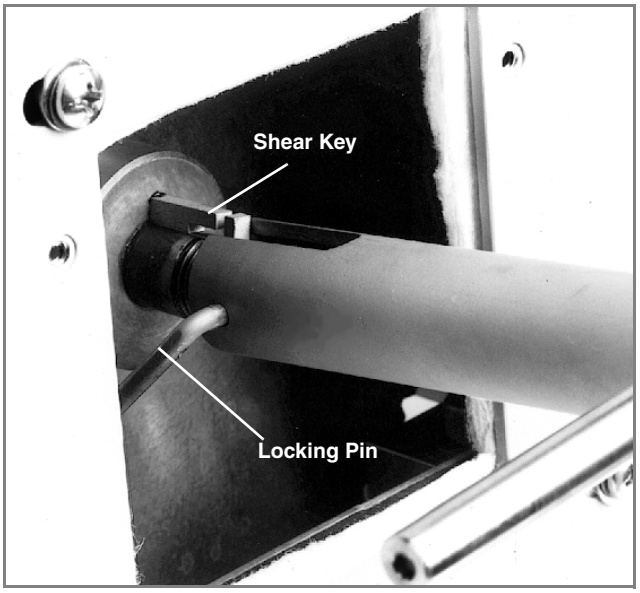


Figure 5-3 Accessing the shear key



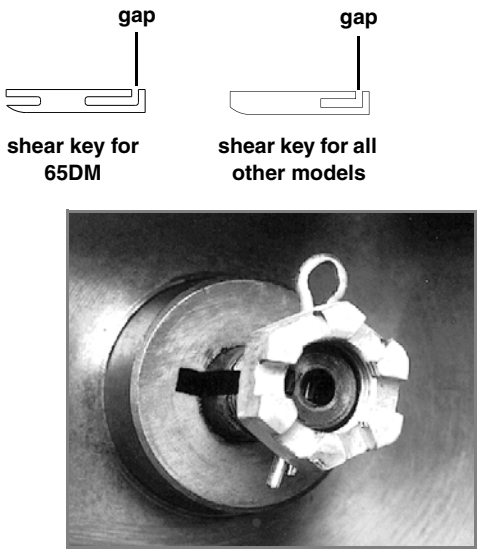
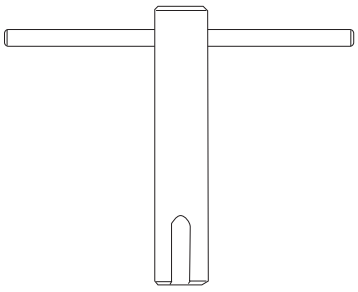


Figure 5-4 Shear key replacement

5.8.1 Replacement Using Installation Tool



A shear key installation tool (part #60-1248-135) is available from Teledyne Isco.

1. Insert tool into ball screw so that the slot on ball screw and tool are lined up, then lock with locking pin.
2. Rotate the ball screw until the broken halves of shear key are realigned (Figure 5-4, above).
3. Remove the broken shear key halves by gripping them with pliers or vise grips and pulling them out.
4. Insert the new shear key into the slot with the gap facing away from the shaft, as shown above. Push the shear key about 1/2-way into the worm gear. Do not push it all the way in.
5. Remove the tool and proceed to the final steps in Section 5.8.4.

5.8.2 Replacement Without Installation Tool

1. Follow steps 1 through 5 in section 5.8.
2. Insert the cotter pin into the ball screw, and screw the castle nut onto ball screw, with the slot on castle nut outward, as shown in Figure 5-4.
3. Use a $^{3}/_{4}$" wrench on the castle nut and rotate the ball screw clockwise until the broken halves of the shear key are realigned (Figure 5-4, above).

⚠ CAUTION

Never use tools on the ball screw. Doing so will render it inoperable and beyond repair.

4. Remove the castle nut and cotter pin.

5. Remove the broken shear key halves by gripping them with pliers or vise grips and pulling them out.
6. Insert the new shear key into the slot with the gap facing away from the shaft, as shown in Figure 5-4. Push the shear key about 1/2-way into the worm gear. Do not push it all the way in.
7. For 65DM pumps, proceed to the next section. For all other pump models, proceed to the final steps in Section 5.8.4.

5.8.3 Pump Bearings (65DM Only)

Follow the step by step instructions in Section 5.8.1 *Replacement Using Installation Tool*, or in Section 5.8.2 *Replacement Without Installation Tool*. Then proceed with the instructions below.

The 65DM pump has an outer bearing set not included in the other pumps. The set includes two thrust washers and one thrust bearing (see Figure 5-5 below).

Figure 5-5 65DM Bearing set

Note that the 65DM spacer is shaped differently from that of other pump models, and must be properly oriented during reinstallation, Figure 5-6.

When performing shear key replacement on the 65DM pump, use care to keep the bearings in position, with the bearing between the two washers, while installing the spacer.

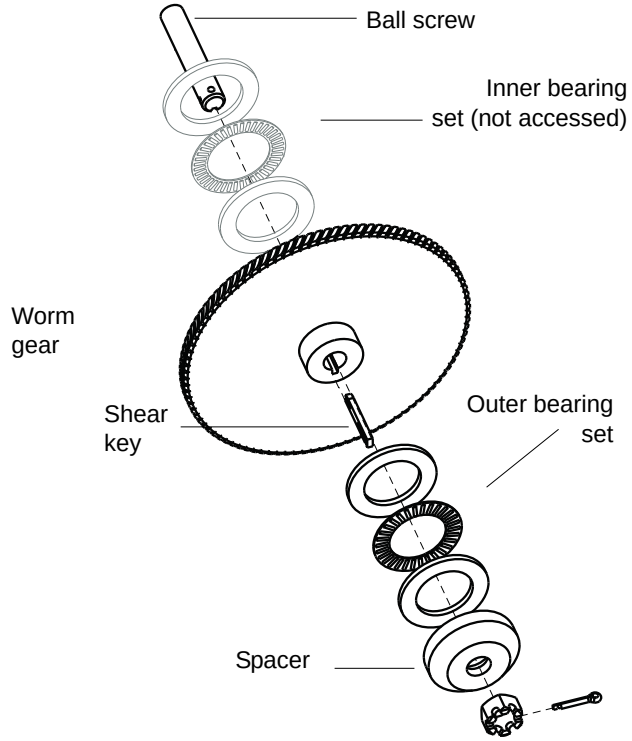


Figure 5-6 65DM Shear key replacement

Proceed to the final steps in Section 5.8.4.

5.8.4 Completion of Shear Key Replacement

1. Slide the spacer onto the ball screw. The spacer will push the shear key into proper position. Install the castle nut on the ball screw. If the shear key isn't completely in the slot, the spacer will position it properly as the castle nut is tightened.
2. Tighten the castle nut.
   a. For the 65DM, torque to **200 in-lbs (23 N-m)**. Do not exceed this limit, or damage to the bearings will occur.
   b. For all other models, torque to **250 in-lbs (28 N-m)**.
3. Loosen the nut until it can be turned by hand. Tighten the nut finger tight.
4. Insert the cotter pin through the castle nut and ball screw. If the holes do not line up, tighten the castle nut until any set of holes allow the cotter pin to be inserted.

⚠ CAUTION

Do not tighten the nut more than 30° beyond finger-tight to align the holes.

5. Reinstall the access cover.

5.9 Motor Brush Replacement

The motor brushes will require inspection approximately every two years of operation or 6,000 strokes (whichever comes first). The normal length of a new brush is 1.1 cm. The brushes should be replaced before they reach 0.4 cm. Only one brush needs to be checked. The other brush will wear at about the same rate. We recommend checking the top brush, as it is much easier to remove and replace.

The upper brush may be removed with the unit in the upright position. The lower brush, which is difficult to remove, is accessed through a hole on the case bottom. While not a preferred method, the lower brush can also be removed by first removing the gear train from the case bottom.

⚠ 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.

To remove the top brush

1. Remove the pump case top as detailed in Section 5.1.3.
2. Locate the upper brush, Figure 5-7 (Configuration 1 or 2, depending on your pump motor type).
3. Remove the wire lead by pulling on the quick disconnect.
4. Unscrew the brush retainer from the motor using a straight edge screwdriver.
5. Once the wire has been removed, pull the brush out.

To replace the top brush

1. Guide the new brush into the slot.
2. Push the spring down and the replace the brush retainer.
3. Tighten the brush retainer with a straight-edge screwdriver.

To remove the bottom brush

1. If you have not already done so, remove the pump case top.
2. Lay the pump on its back so that you can access the hole in the case bottom. Remove two screws which secure a cover plate over the access hole.
3. Remove the wire lead by pulling on the quick disconnect.

4. Insert a straight-edge screwdriver through the hole and unscrew the brush retainer. It's quite easy to drop the retainer into the case if you aren't careful. Using a larger screwdriver or putting a dab of adhesive on the end of the screwdriver will prevent this from occurring.
5. Once the retainer has been removed, the brush can be pulled out. You can use needle-nose pliers or your first two fingers to tug on the brush.

To replace the bottom brush

1. Connect the new brush to the wire lead.
2. Look through the hole on the case bottom and use your fingers to push the wire lead so that the brush moves near the slot.
3. When you have the brush aligned with the slot, use a straight-edge screwdriver to push the brush into the slot.
4. Once the brush has been pushed into the slot, hold it in place with the screwdriver. Then, holding the brush retainer between your first two fingers, reach your hand inside the pump case (between the circuit board and the motor) and align the retainer over the slot.
5. Move the screwdriver as you put the retainer in place.
6. Then, tighten the brush retainer with a straight-edge screwdriver.

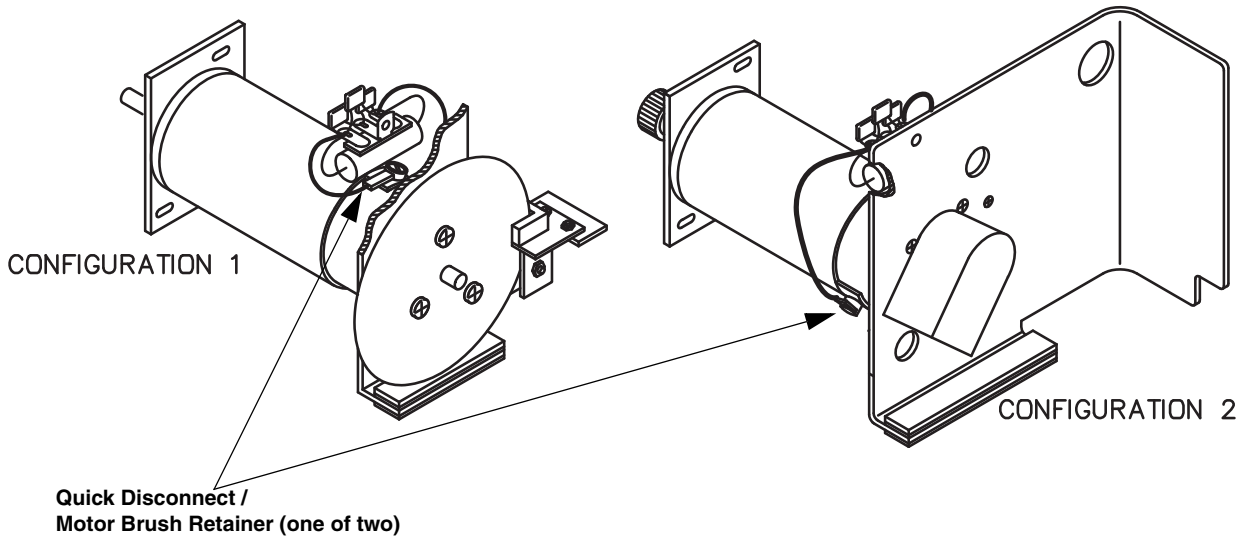


Figure 5-7 D Series motor brush replacement

☑ Note

Parts for Configuration 1 and Configuration 2 are not interchangeable.

5.10 Troubleshooting

The following sections contain tables listing the most commonly used test points and their voltages. Refer to the controller schematic and the pump schematic (available online on our Web site).

⚠ 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.

5.10.1 Power Supply (A1)

Output voltages of the power supply can be verified. The voltages in the pump unit, between circuit common (TP106) and the fuses or at the test points should be:

F104	+22 VDC	to +31 VDC
F103	+8.1 VDC	to +13 VDC
F102	–22 VDC	to –31 VDC
TP111	+15 VDC	± 0.6 VDC
TP110	–15 VDC	± 0.6 VDC
TP109	+5 VDC	± 0.3 VDC

The voltage between motor common (TP101) and +VM (TP105) should be + 30 V to + 45 V (low speed) or +60 to +90 V (high speed). See section 4.

5.10.2 Controller

The voltages in the controller unit between circuit common (TP134) and the test points should be:

TP106	+5 VDC	± 0.002 VDC
TP112	+8.1 VDC	to +13 VDC
TP131	–15 VDC	± 0.6 VDC
TP135	+15 VDC	± 0.6 VDC
TP136	+10 VDC	to +12 VDC
TP137	–10 VDC	to -12 VDC

5.11 Calibration

It should not be necessary to readjust the instrument unless repairs have been made on the electronic circuitry or the controller cable length has been changed.

Only pump A must be adjusted.

5.11.1 +5 Volts Adjustment (on A1 board)

The 5-volt adjustment is done in the pump unit, with the voltage measured at the controller.

1. Connect a voltmeter to TP106 and to common TP134 (both of which are located on the controller board).
2. Adjust R133 on the pump CBA until the voltage at TP106 reads 5.0 volts, ±0.002 V.

5.11.2 Pressure Transducer Calibration for 65DM, 100D, 260D, 500D, and 1000D

This adjustment is done on the pressure preamp board on top of the cylinder. The A0 portion of the schematic details this board.

To access this board, remove the amplifier cover at the top of the pump. Connect a valve with inlet tubing and a 10 micron filter to one port of the pump. Connect a pressure gauge with a precision of 0.25% accuracy to the second pump port. Both the valve and the gauge must be rated above the maximum pressure of the pump.

Then, do the following:

1. Fill the pump with fluid.
2. With the fittings in both ports tight and the valve open, adjust R61 (offset) on the pressure preamp board for 0.000, ±0.050 V at TP52, with respect to TP51.
3. Press ZERO PRESS and close the inlet valve.
4. Put the pump in constant pressure mode. Enter a pressure setpoint of 69 bar, then press the RUN key.
5. When the pressure is stable, adjust R53 (gain) so that the pressure gauge reads 69, ±3 bar.
6. Enter the maximum pressure.
7. When the pressure is stable, adjust R53 to match the pressure gauge reading to the pressure setpoint, to within 1.7 bar.

5.11.3 Pressure Transducer Calibration for 65D

The 65D pump requires a different calibration procedure than that of the other models. This procedure requires a #2 Phillips screwdriver, a small, flat screwdriver, and a voltmeter.

1. Connect an external pressure gauge to the system.
2. Perform a system reset and hard reset on the controller (refer to Section 3.3.4 *Resetting the System*) to clear any zero offsets.

⚠ CAUTION

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

3. Remove the four screws holding the pump base cover in place, and remove the cover to expose the PreAmp CBA (Figure 5-8, below).

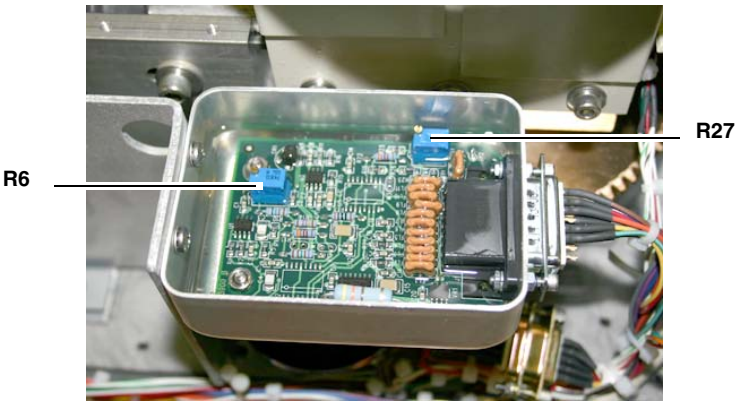


Figure 5-8 65D PreAmp CBA

4. Connect the voltmeter to **J14** (left red banana plug on the pump rear panel, Figure 5-9), and **J16** (black center banana plug).

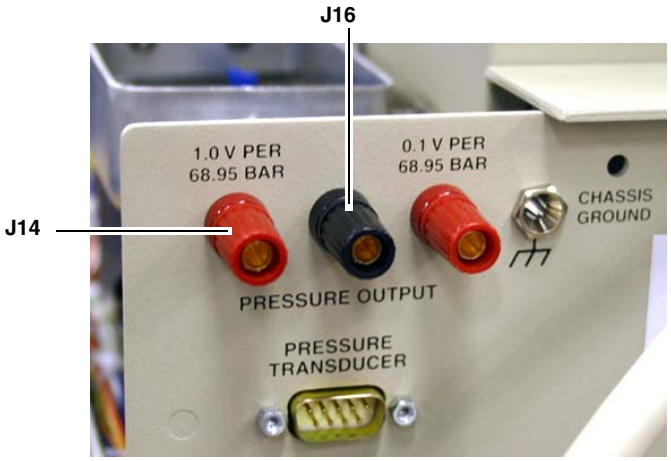


Figure 5-9 Pressure output jacks, pump rear panel

5. On the PreAmp CBA, adjust **R6** to 0 VDC ±.010 at J14 with reference to J16.
6. On the controller, press ZERO PRESS, and zero the pressure for the appropriate pump.
7. Enter a set pressure (such as 5,000 psi) and run the pump to that pressure. On the PreAmp CBA, adjust **R27** until the pressure gauge reads the set pressure.
8. Run the pump up to 10,000 psi, checking the pressure gauge for accuracy. If the reading is not within ±25 psi, readjust **R27** to match the set pressure.

9. Run the pump up to 20,000 psi, checking the pressure gauge for accuracy. If the reading is not within ±25 psi, readjust **R27** to match the set pressure.

5.11.4 Reset Circuit

This adjustment is required if U101, and the ICL 7665, is replaced. It is done on the circuit board in the controller unit.

1. Connect the common of the voltmeter to TP134.
2. Turn the standby switch to the on position.
3. Adjust R133 of the power supply circuit board in the pump unit to obtain a voltage of 4.875 ±0.001 volts at TP106 in the controller unit.
4. Adjust R113 in the controller unit slowly clockwise until the voltage at TP105 switches high (approximately +5 volts).
5. Adjust R133 of the power supply board in the pump unit to regain a voltage of 5.000, ±0.002 volts at TP106 in the controller unit.

5.11.5 A/D Circuit Adjustment

This adjustment is done in the controller unit.

1. Connect the common of the voltmeter to TP138.
2. Turn the standby switch to the on position.
3. Adjust R135 to obtain a voltage of 4.587 volts at TP124.
4. Place a jumper between TP133 and TP139.
5. Adjust R138 to obtain a voltage of 2.081 volts at TP139.
6. Remove the jumper.
7. Place a jumper between TP133 and TP138.
8. Adjust R139 to obtain a voltage of 3.537 volts at TP139.
9. Remove the jumper.

5.11.6 Limit Sensor Adjustment

In the event that the limit sensors must be replaced on the pump, use the following procedure:

1. Disconnect the instrument from mains power.
2. Disconnect the pressure transducer cable from the pump, and remove the tubing from the inlet and outlet ports.
3. Loosen the four cover screws and remove the front and rear covers of the pump.
4. The cylinder must be unscrewed several turns to avoid accidentally bottoming the piston out during calibration of the limit sensor. Therefore, loosen the cylinder lock screw. The lock screw is located in the front side of the cylinder mounting block and is a ¼-20 setscrew.
5. The limit sensor assembly includes two limit sensors, the wire harness and connector, and a conduit which protects the wires running between the sensors, Figure 5-10.

   Depending upon when your pump was manufactured, the protective conduit may be directly fastened to the pump or retained with mounting tabs and cable ties.

If the conduit is fastened directly to the case, then it must be removed and the plastic mounting tabs included with the limit sensor assembly package should be installed using the existing screws and screw holes.

To install the mounting tabs

a. Remove the screws and the conduit.

b. Then use the same screws and holes to install the mounts. Be sure the tab portion of the mount is facing away from the sensors, as shown in Figure 5-11, (the screw aperture is closest to the sensors).

If your pump already has the plastic tabs installed, cut and discard the plastic cable ties which run through the tabs and hold the conduit.

6. Remove the four screws holding the limit sensors, and unplug the cable from the power circuit board. (The replacement limit sensor assembly includes both the upper and lower sensor and the plug.)
7. Install the new limit sensor harness; and secure the protective conduit by running the cable ties through the mounts and tightening. Then cut the excess cable tie and discard.

☑ *Note*

Be sure the circuit board connector is mated pin-for-pin with the jack.

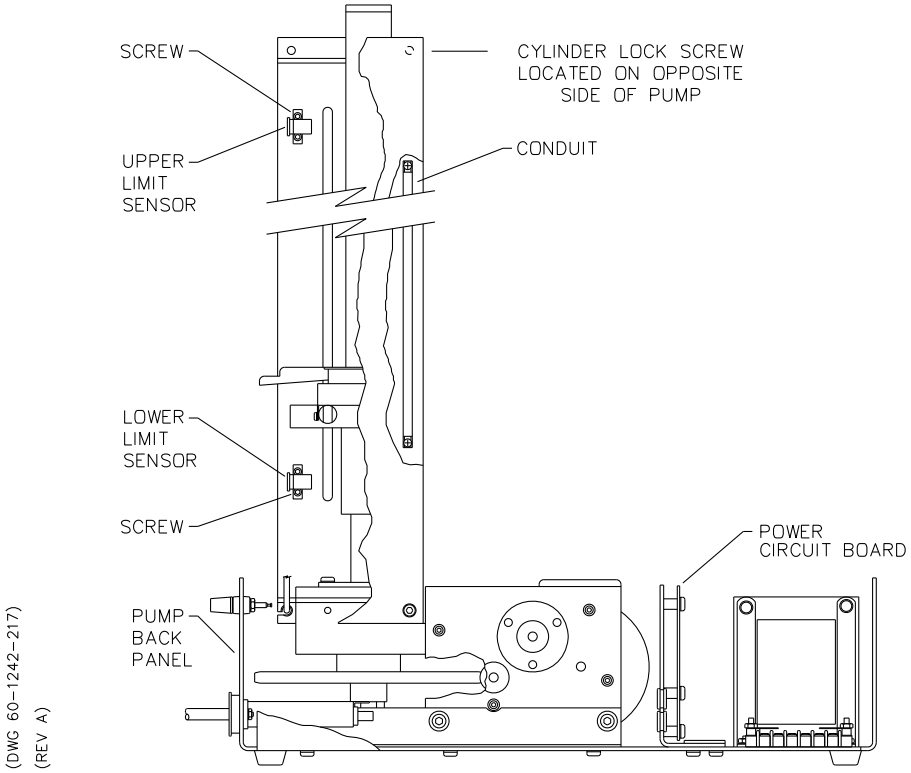


Figure 5-10 Limit sensor replacement

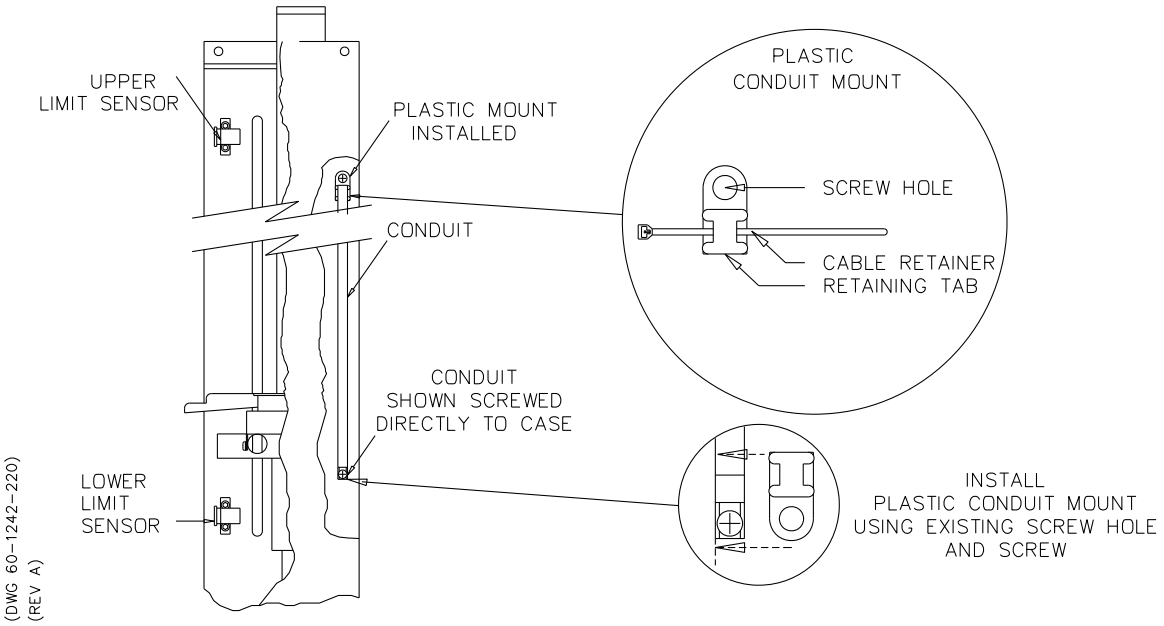


Figure 5-11 Installing the plastic mounts

8. Be sure that the cylinder is unscrewed several turns. If you need to use a wrench, we recommend a strap wrench or wrenches in the Teledyne Isco wrench package (P/N 68-1247-067 for 65DM, 100DM, 100DX, 260D, and 65D; P/N 68-1247-068 for 500D; P/N 60-1247-093 for 1000D) which will not mar the cylinder's outer surface.
9. Center the pump bottom limit sensor with respect to the mounting screws and tighten them.
10. Raise the top limit sensor to the extent of the slots and tighten the upper screw.

Now the new limit sensors MUST be calibrated, as explained in the following section.

5.11.7 Limit Sensor Calibration

Once the new limit sensor assembly is installed, the sensors must be calibrated. Before calibrating the limit sensors, be sure the cylinder is unscrewed several turns. Follow steps 8-10 in the previous section (5.11.6). Use the following procedure to calibrate the limit sensors:

1. Connect the pressure cable and power cord and turn the controller ON.
2. Press REFILL and enter the maximum rate.
3. Press STOP when the interrupter flag is approximately ¼" from the full (lower) sensor.
4. Press 'A' (FLOW RATE), and use the number key to set 10 (ml/min). Press the ENTER key.
5. Press REFILL.
   After the lower limit sensor is interrupted, the motor will stop.
6. Press CONST FLOW.
7. Press 'A' (FLOW RATE) and select MAX.
8. Press RUN.
9. Press STOP when the volume counter in the upper right-hand corner of the LCD reads 005.00 ml or less.
10. Press 'A' (FLOW RATE) and enter 5 ml/min.
11. Press RUN .
12. Press STOP when the counter reads 0.30 or less.
13. Press 'A' (FLOW RATE) and enter 1 ml/min.
14. Press RUN.
15. When the counter counts from 000.01 to 000.00 press STOP.
16. Lower the upper limit sensor to the point where the flag just interrupts the sensor. ("CYLINDER EMPTY" will flash on the screen.)
17. Tighten the top upper limit mounting screw.
18. Turn the controller to STANDBY and disconnect the pressure cable.
19. Screw the cylinder into the cylinder mounting block until the cylinder snugly bottoms against the piston (the cylinder will no longer turn).
20. Unscrew the cylinder a minimum of ½ turn, then line up the inlet and outlet ports as you had them before.
21. Lock the cylinder by tightening the locking screw.
22. Connect the pressure cable and power cord and turn the controller ON.
23. Press the REFILL key. Wait until you have access to the second upper limit sensor mounting screw and tighten it.
24. Install the covers.

D Series Syringe Pumps

Section 6 Serial Interface

6.1 Introduction

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

- Section describes the DASNET protocol
- Section 6.4 describes the proper cabling connections for serial control
- Section 6.5 details the serial commands
- Section 6.6 details the procedure for placing your controller(s) in serial control mode.

6.2 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.

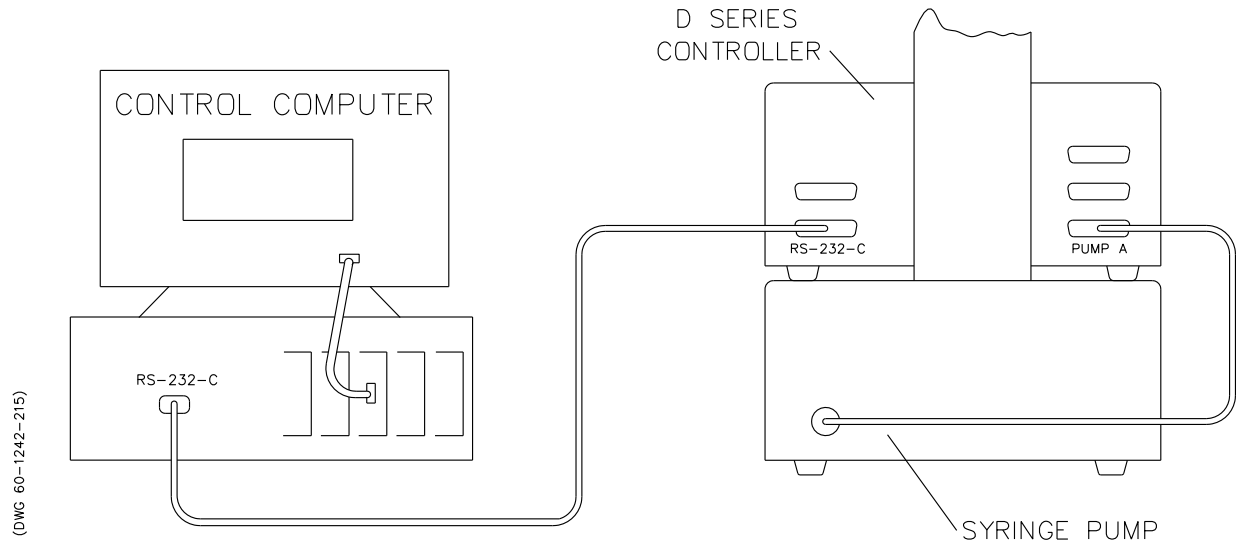


Figure 6-1 Single serial network connection example (rear view)

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 6.6). 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 D 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 6-1. 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 (see section 6.6).

Table 6-1 External control connector serial pin connections

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

6.3 User-written Software

When designing software to control the D 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 nine D 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 6-1 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.

6.3.1 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 6-2 is an example BASIC language program which performs the required portion of the DASNET serial protocol. Table 6-3 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.

Table 6-2 Example of BASIC program to demonstrate conversion of pump commands to DASNET frames

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

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

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

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

Table 6-3 Example of C program to demonstrate conversion of pump commands to DASNET frames

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

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

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 D 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 6.5. 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 6.5 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 D Series controller is limited to single commands. It will respond with a PROBLEM=INVALID COMMAND message.

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

Cable Connections

One or two controllers: – To connect one controller, use cable 480-7996-00. If only two controller are being connected in the network, then a single cable, 68-1020-198, is all that is required. It is connected between the 9-pin serial output connector of the computer and the RS-232-C connector on the rear of up to two controllers, as shown in Figure 6-2.

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

Three or more controllers: – If additional instruments are to be connected in series, a special daisy chain cable, P/N 68-1020-180, will be required. The 1020-180 cable is attached to the last connector on the 1020-198 cable shown, in Figure 6-2, and then plugged into the RS-232-C connectors on the back of the additional controllers.

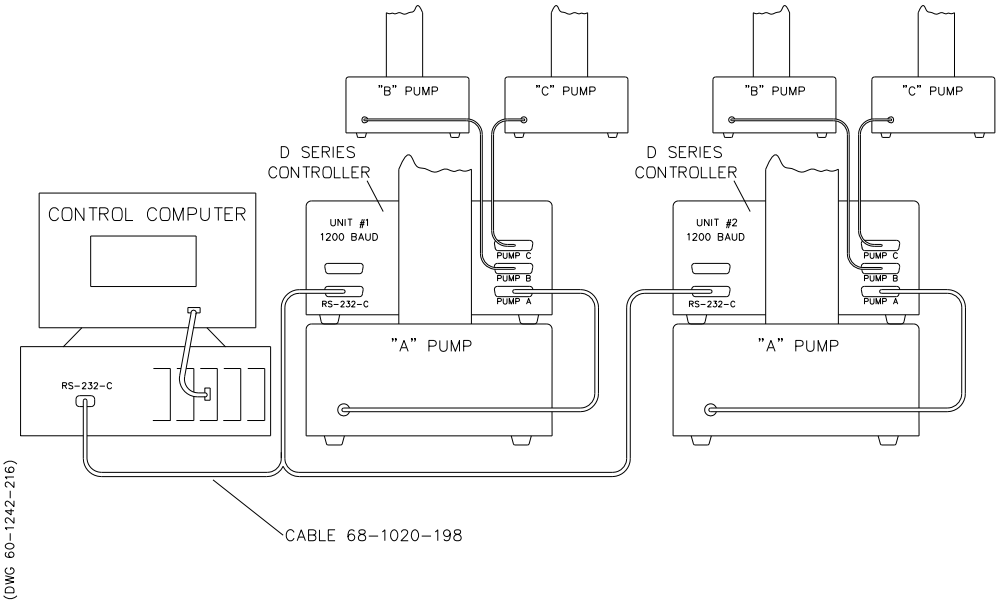


Figure 6-2 Serial network connection example

6.5 Serial Commands for the D Series Pump

Table 6-4 is a list of the serial commands recognized by the pump. These commands are the message part of the DASNET protocol. The operand always follows the equals sign. The REMOTE command must be sent once, before any command that changes the operation of the pump will be accepted.

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

Table 6-4 Serial Commands

Command	Description
%B=#	Enter # for percentage of modifier.
ALOG1	Status of the analog voltage input on pin 21, P114. See NOTE 1.
ALOG2	Status of the analog voltage input on pin 15, P107 auxiliary DB25 connector and on analog input 3 of the accessory connector. See NOTE 1.
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 on pin 2, P107 auxiliary DB25 connector. See NOTE 1.
CLEAR	Stops all motors, sets flow rate and pressure setpoints to zero.
CONTIN CONST FLOW	Puts pump in continuous flow under constant flow mode.
CONTIN CONST PRESS	Puts pump in continuous flow under constant pressure mode.
CONST FLOW CONST FLOWB CONST FLOWC	Put pump in constant flow mode.
CONST PRESS CONST PRESSB CONST PRESSC	Put pump in constant pressure mode.
DIGITAL	Returns the status (High or Low) of the digital outputs. Format is digital = xxxxxxxx, where “x” is either “H” or “L”. The status order returned corresponds with the outputs 1—8.
DIGITAL = xxxxxxxx 1——— 8	Sets the digital output either High or Low, where “x” is either “H” or “L”. The order corresponds with the outputs 1—8.
DIG CONTROL	Returns the status of the digital output control bits as either REMOTE (R) or INTERNAL (I). The return message format is DIG CONTROL=xxxxxx, where “x” is either “R” or “I”. “R” indicates the corresponding bit is controlled remotely; and “I” indicates the corresponding bit is controlled internally by pump software. The status order returned corresponds with the outputs 1—8.
DIG CONTROL = xxxxxxxx 1——— 8	Sets the digital output control bits to either internal or remote, where “x” is either “R” for REMOTE or “I” for INTERNAL CONTROL. “R” indicates the corresponding bit will be controlled remotely (through the serial port). “I” indicates the corresponding bit will be controlled internally by pump software. The order corresponds with the outputs 1—8.
FLOW	Returns the delivering pump’s flow rate in continuous pumping mode and modifier addition mode. In INDEPENDENT mode it returns the pump A flow rate.

Table 6-4 Serial Commands (Continued)

Command	Description
FLOWA FLOWB FLOWC	Returns the actual flow rate of the pump.
FLOW=# FLOWB=# FLOWC=#	Returns the actual flow rate of the pump Enter # for a flow rate setpoint (constant flow mode). Format is XXX.XXXXXXX ml/min. Only 5 figures are significant. Leading and trailing zeros are not required.
G G&	Gets pump information. "G" returns a text string that contains current pressure, analog input, and digital input information. "G&" is the Get All command. This returns the same information as "G," plus flow rates, units, operation status, and more. Refer to 6.5.1 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=1240-024, MODEL 100DM PUMP SERIES=1240-027, MODEL 100DX PUMP SERIES=1240-021, MODEL 260D PUMP SERIES=1240-025, MODEL 500D PUMP SERIES=1240-052, MODEL 1000D PUMP SERIES=1240-063, MODEL 65D PUMP
INDEPENDENT	Put pumps in Independent mode.
IPUMPA=1, IPUMPA=0 IPUMPB=1, IPUMPB=0 IPUMPC=1, IPUMPC=0	Turns the pressure integral control On and Off for the pump indicated. 1 = ON 0 = OFF
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.
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."
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 6.5.2 for complete information on Gradient step download commands.
LGUL,F:xx,S:xx	Gradient Step Upload command. This transfers a step from the PC to the controller. Refer to 6.5.3 for complete information on Gradient step download commands.
LIMITS LIMITSB LIMITSC	Returns the pressure and flow rate limits.
LOCAL	Returns the instrument to local control. Front panel control is enabled and all motors are stopped (if control was previously remote).
MAXFLOWA=# MAXFLOWB=# MAXFLOWC=#	Enter # to designate the maximum flow rate setpoint.
MAXFLOWA MAXFLOWB MAXFLOWC	Returns the maximum flow rate setpoint.

Table 6-4 Serial Commands (Continued)

Command	Description
MAXPRESSA=# MAXPRESSB=# MAXPRESSC=#	Enter # to designate the maximum pressure setpoint.
MAXPRESSA MAXPRESSB MAXPRESSC	Returns the maximum pressure setpoint.
MFLOWA=# MFLOWB=# MFLOWC=#	Enter # to designate the maximum flow limit in constant pressure mode.
MFLOWA MFLOWB MFLOWC	Returns the maximum flow limit setpoint.
MINFLOWA=# MINFLOWB=# MINFLOWC=#	Enter # to designate the minimum flow rate setpoint.
MINFLOWA MINFLOWB MINFLOWC	Returns the minimum flow rate setpoint.
MINPRESSA=# MINPRESSB=# MINPRESSC=#	Returns the minimum flow rate setpoint.
MINPRESSA MINPRESSB MINPRESSC	Returns the minimum pressure setpoint.
MODIFIER	Put pumps in modifier addition mode.
PRESS=# PRESSB=# PRESSC=#	Enter # to designate pressure setpoint (constant pressure mode).
PRESS	Returns the delivering pump pressure in continuous pumping mode and modifier addition mode. In INDEPENDENT mode it returns the pump A pressure.
PRESSA PRESSB PRESSC	Returns the actual pressure of the pump.
PRESSCNTRLDIFF1	Sets the pressure control input to Analog input 1, with a pressure range of 50 psi.
PRESSCNTRLDIFF1=XXXXX	Sets the pressure control input to Analog input 1 and sets the pressure range. The range is 1 to 5000. the units are psi, with a value of 5000 representing 5000 psi at 5 volts.
PRESSCNTRLDIFF2	Sets the pressure control input to Analog input 2, with a pressure range of 500 psi at 5 volts.
PRESSCNTRLDIFF3	Sets the pressure control input to Analog input 2, with a pressure range of 5000 psi at 5 volts.
PRESSCNTRLNORM	Sets the pressure control input to the standard input.
PRESSDIFF=XXXXX	Differential pressure setpoint. (PSI*10) 0 to 50,000 maximum (0 to 5000 psi)
PRESSDIFF	Reads the differential pressure value. (PSI*10) The transducer can also be read via the “ANGLx” serial commands.

Table 6-4 Serial Commands (Continued)

Command	Description
RANGEA RANGEB RANGEC	Provides scaling information for the system parameters. See 6.5.4 for more information about this serial command.
RAPIDA RAPIDB RAPIDC	Activates the automatic rapid pressurization cycle (constant flow mode only).
REFILL REFILLB REFILLC	Move cylinder to bottom at preset refill rate.
REFILL=# REFILLB=# REFILLC=#	Enter # to designate refill rate.
REMOTE	Disables controller front panel control and enables all serial commands. Stops all motors (if control was previously local).
RLIMITA RLIMITB RLIMITC	Returns the refill flow rate limit.
RSVP RSVPB RSVPC	Pump responds with “READY” message.
RUN RUNB RUNC	Same as front panel. Initiates pumping.
SETFLOWA SETFLOWB SETFLOWC	Returns the flow rate setpoint.
SETPRESSA SETPRESSB SETPRESSC	Returns the pressure setpoint.
STATUSA STATUSB STATUSC	Returns with status of pump. May be any combination of responses listed below. **STATUS=** STOP, RUN, REFILL, HOLD, EQUIL., LOCAL, REMOTE, EXTERNAL **PROBLEM=** OVER PRESSURE, UNDER PRESSURE, CYLINDER FULL, CYLINDER EMPTY, MOTOR FAILURE
STOP STOPB STOPC	Same as front panel, except that pump remains under remote serial control.
UNITSA=	Enter the desired flow or pressure units after the equal sign. Acceptable values are: ATM, BAR, KPA, PSI, ML/MIN, ML/HR, UL/MIN, UL/HR. (Sets all pumps.)
VOLA VOLB VOLC	Return the volume remaining in cylinder in ml. Format is “XXX.XXXX” ml.
VOLTOT	Returns the total volume delivered when using continuous flow or modifier.
VOL RESET	Will reset the volume total to zero.

Table 6-4 Serial Commands (Continued)	
Command	**Description**
ZEROA ZEROB ZEROC	"Zeros" the pressure sensor offset for analog input 1.
ZERODIFF1 ZERODIFF2 ZERODIFF3	"Zeros" the pressure sensor offset for the respective analog input.
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: $\frac{\text{number} - 7500}{5000}$ = volts $\qquad$ $\frac{(32500 - 7500)}{5000}$ = 5 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.	

6.5.1 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 6-3 and 6-4.

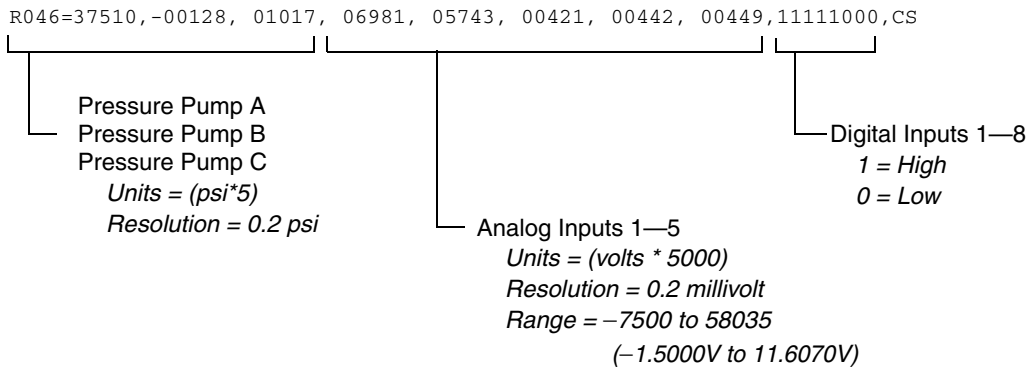


Figure 6-3 Get Status String

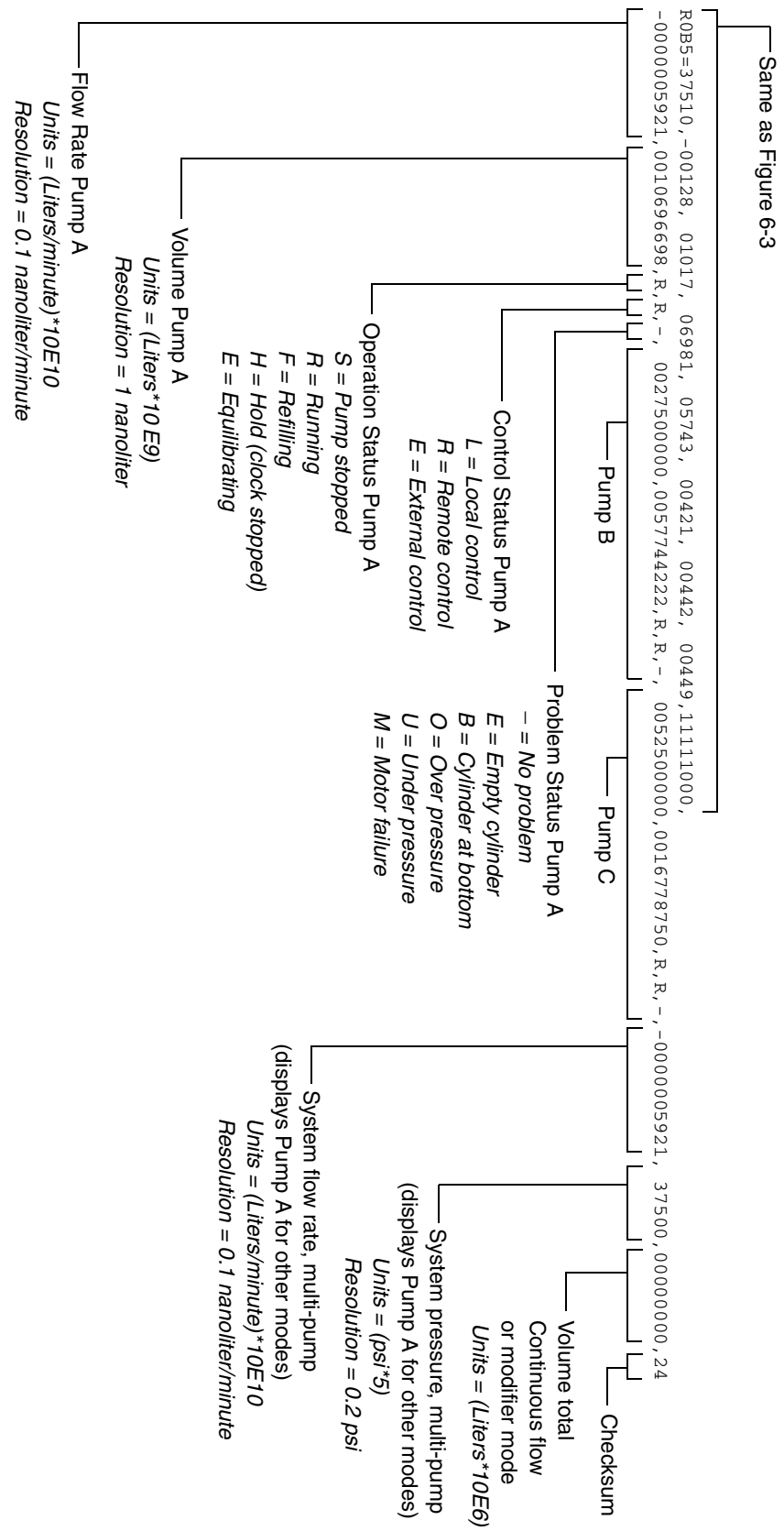


Figure 6-4 Get All Status String

6.5.2 Gradient Download Command

This command downloads a step from the D 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 6-5 and 6-6.

6.5.3 Gradient Upload Commands

These commands upload a step from the PC to the D 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 6-7 and 6-8. Figure 6-9 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.

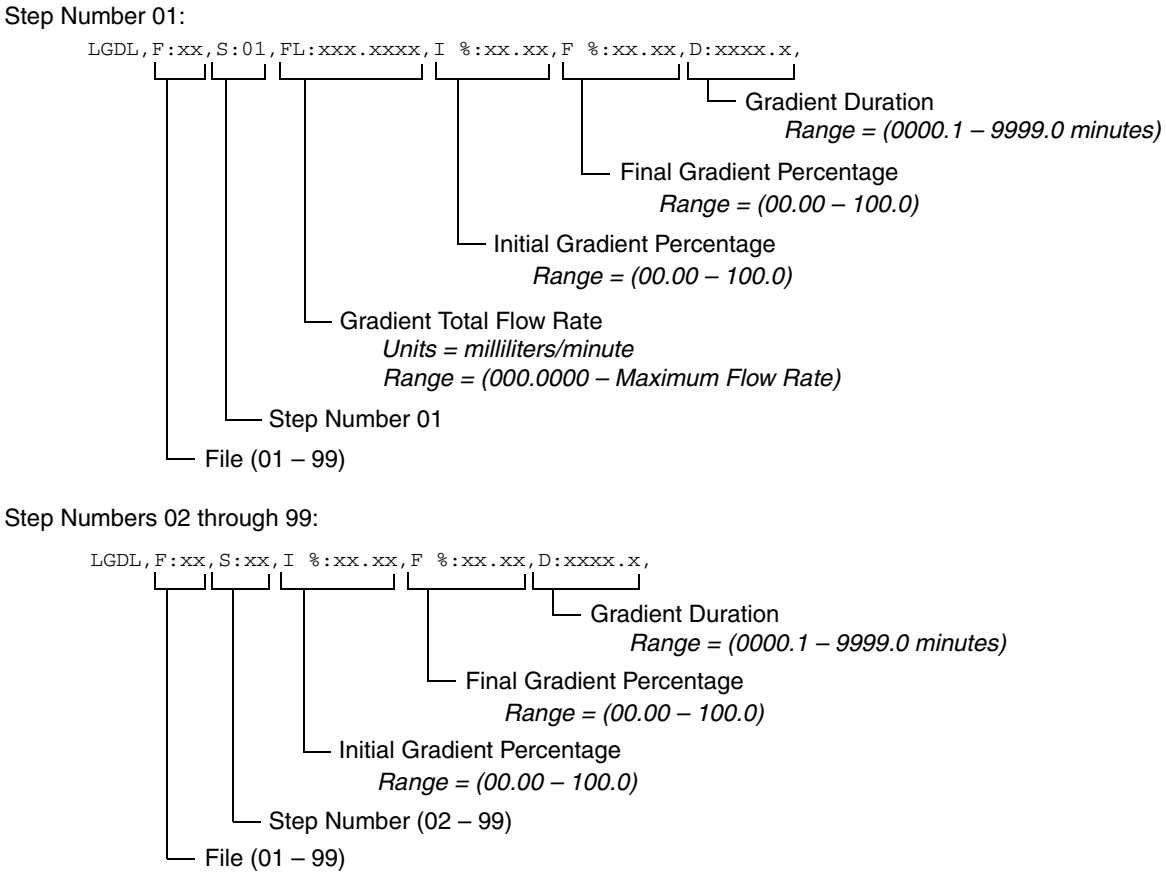


Figure 6-5 Gradient Download Commands - Single pump flow gradient

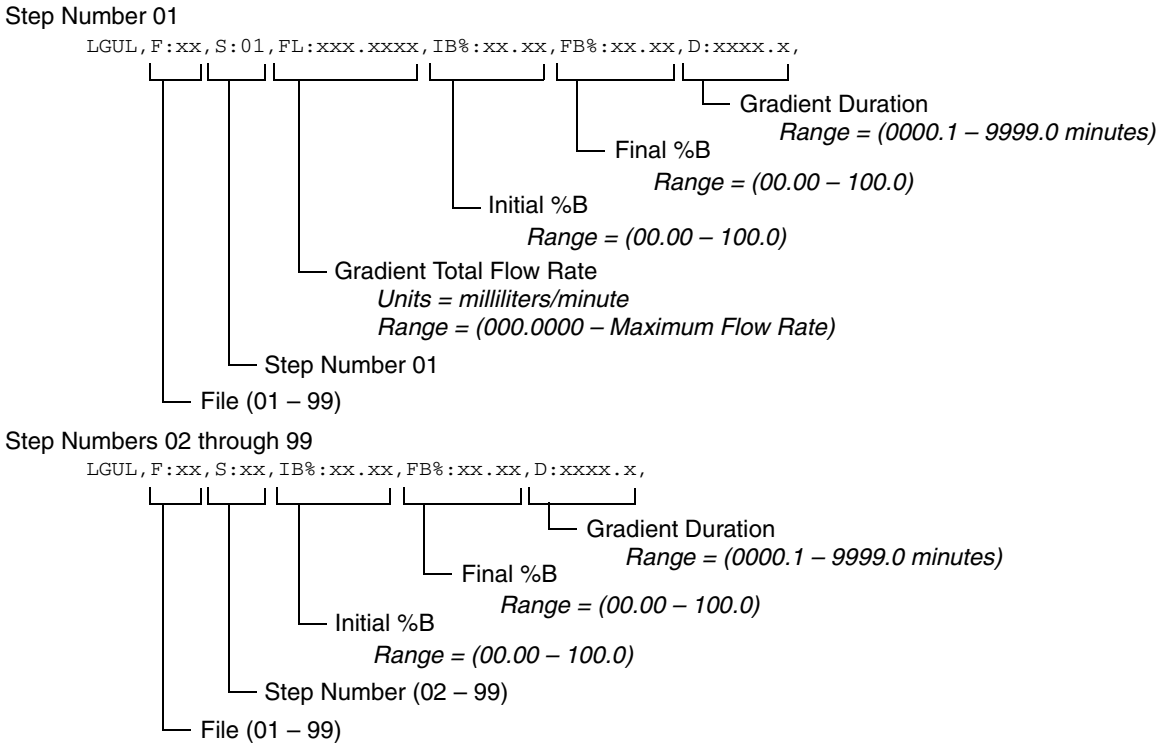


Figure 6-6 Gradient Download Commands - Two pump flow gradient

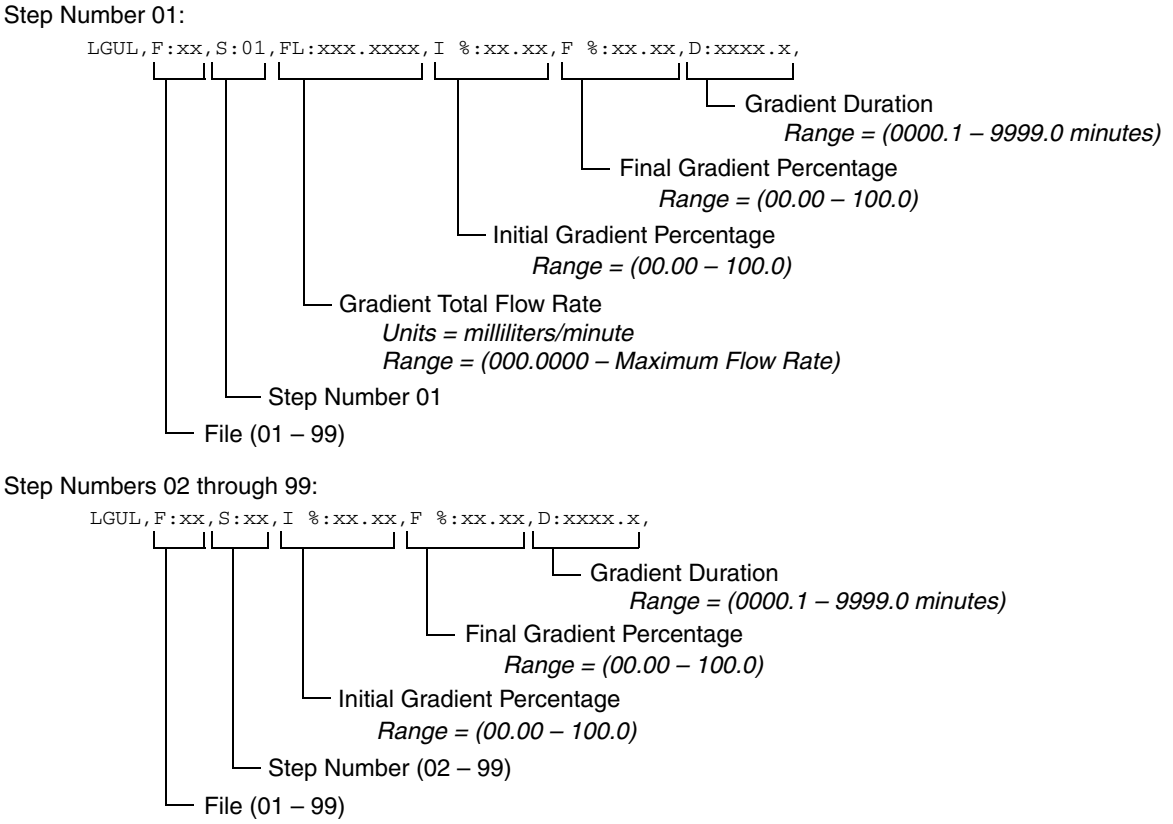


Figure 6-7 Gradient Upload Commands - Single pump flow gradient

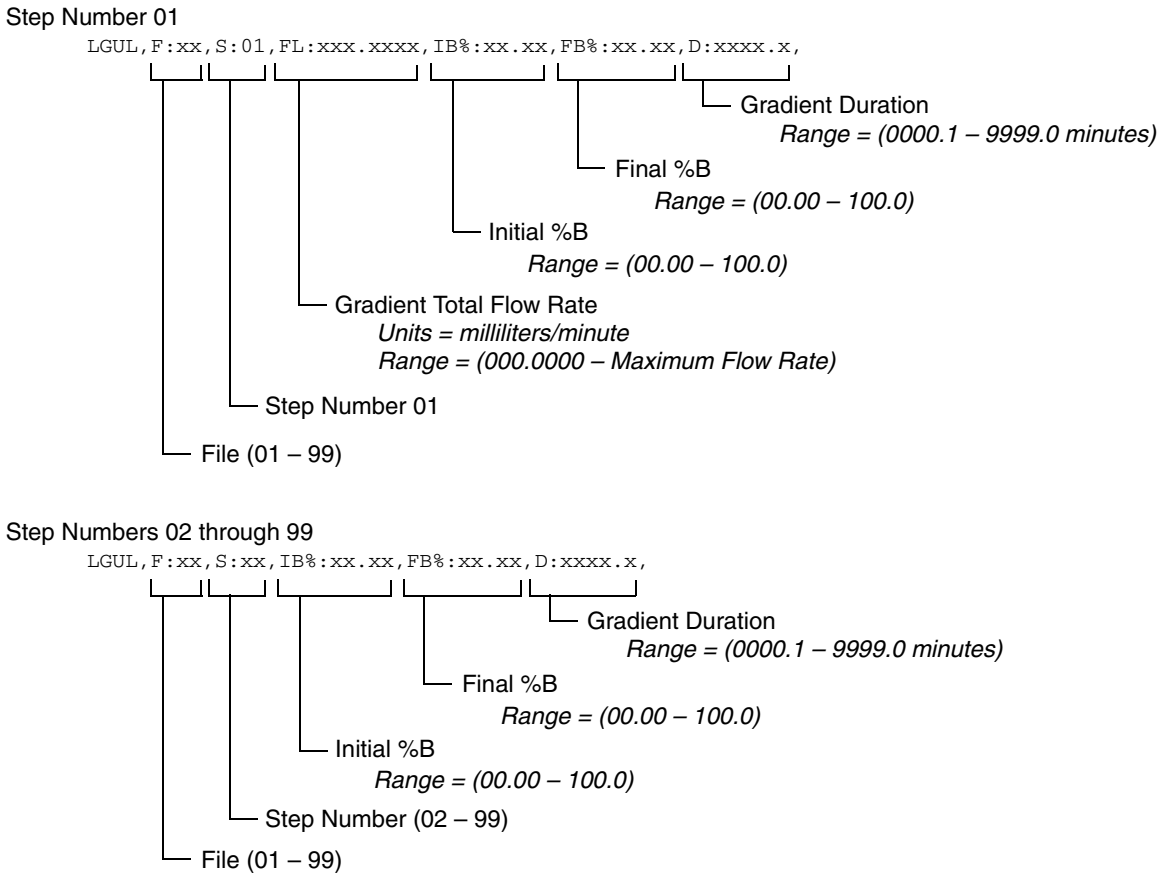


Figure 6-8 Gradient Upload Commands - Two pump flow gradient

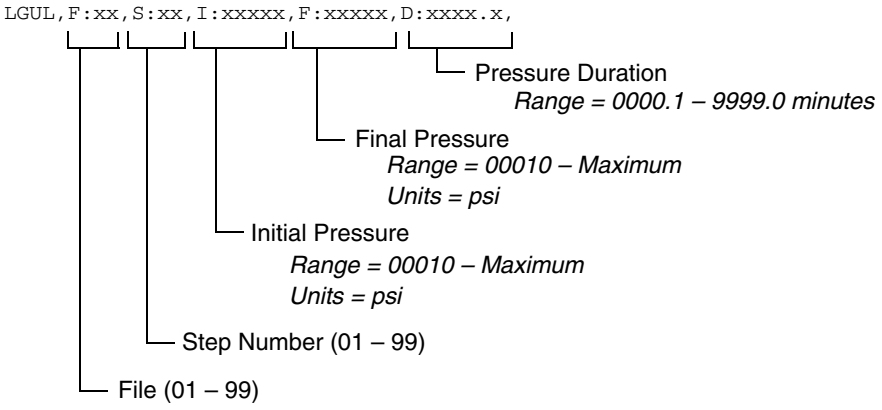


Figure 6-9 Upload Commands - Single pump pressure programming

6.5.4 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 6-10.

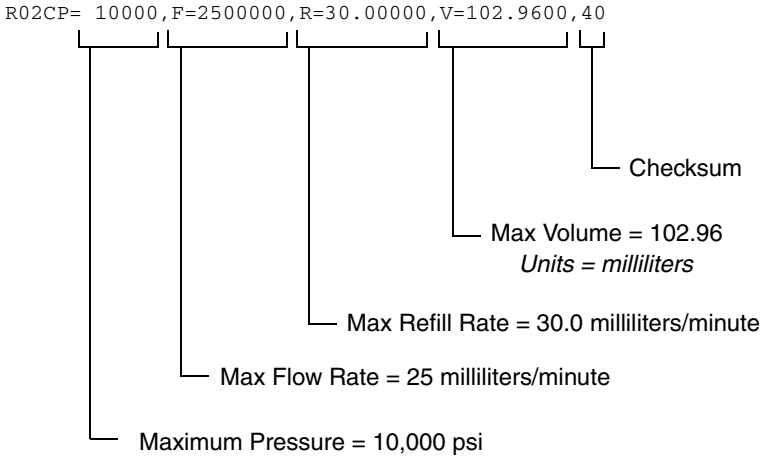


Figure 6-10 Range Serial Commands

6.5.5 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 6-5.

Table 6-5 Error Messages

Error	Description
PROBLEM=LOCAL MODE	The pump was sent a command before being placed in remote mode. See Section 6.5.
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.

6.6 Serial Control Set-up

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

To set up for serial control

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

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

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

D Series Syringe Pumps

Section 7 Gradient Pumping for Pressure, Flow, and Concentration Modes

7.1 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.

All Teledyne Isco syringe pump models can be used in gradient mode. The model 65D requires special hardware for this. Call the factory for complete information.

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 7-1

Manual Outlet Valve Kit - see Table 7-2

Tools and Parts for Dual Pump System

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

Manual Refill Valve Kit -
see Table 7-1 (two kits required)

Gradient Mixer Package - part #68-1247-080

Table 7-1 Manual Refill Valve Kits

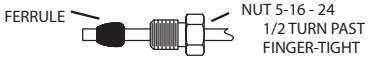
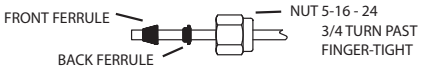
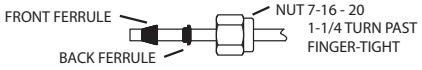
Pump Model	Part Number
1000D	68-1247-117
500D	68-1247-083
65DM, 100DM/DX, 260D	68-1247-077
65D	68-1247-127

Table 7-2 Manual Outlet Valve Kits	
Pump Model	**Part Number**
1000D	68-1247-118
500D	68-1247-082
65DM, 100DM/DX, 260D	68-1247-078
65D	68-1247-126

7.2 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 7-3 for standard port information.

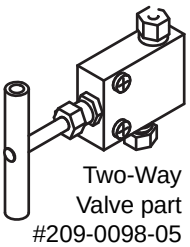
When making fluid connections that use ferrules, be sure to use the ferrules supplied for that pump by Teledyne Isco. Push the tubing completely into the connector and finger-tighten. Then tighten with a wrench to clamp the ferrules onto the tubing.

Table 7-3 Swaging Detail		
65DM, 100DM/DX, 260D	1/8" Valco	
500D	1/8" NPT	
1000D	1/4" NPT	
65D	1/4" F250C	Call Teledyne Isco.

☑ *Note*

Pump models 260D, 100DM/DX, and 65DM have a direct connection, as shown in Figures 7-1 and 7-2 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.

7.2.1 Inlet Connections

Kit components and connections are shown in Figure 7-1.

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).

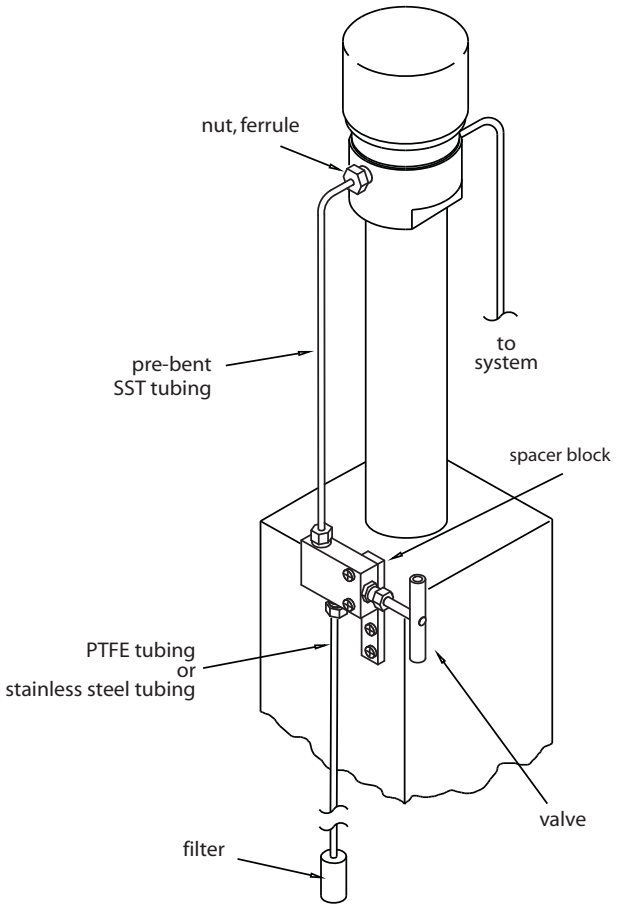


Figure 7-1 Pump inlet connections

7.2.2 Outlet Connections

Kit components and connections are shown in Figure 7-2.

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 1/8" tubing to the other port of the valve, using the valve fittings.
4. Connect the 1/8" side of the reducing union to the tubing.
5. Connect the 1/16" side of the reducing union to the 1.5 m length of 1/16" tubing. (This tubing may be cut to an appropriate length.)

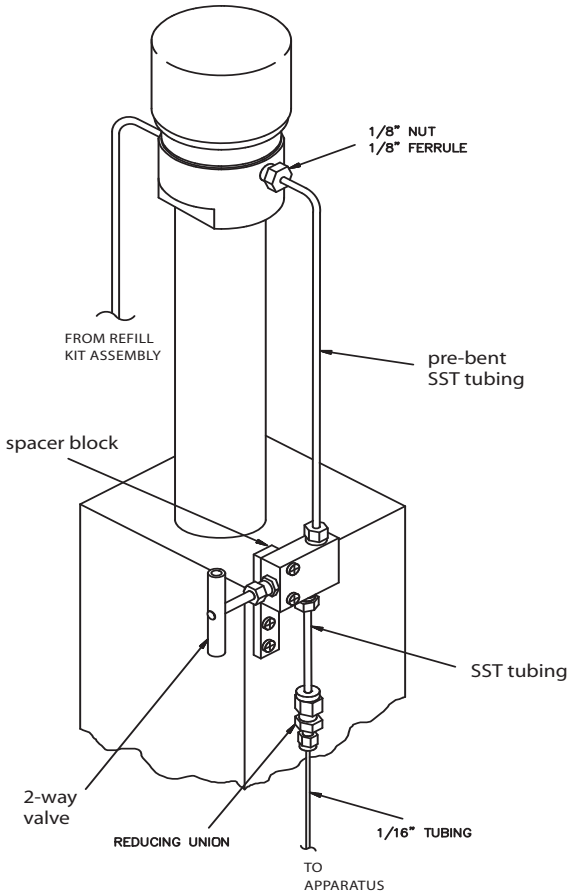


Figure 7-2 Pump outlet connections

7.2.3 Dual System Gradient Connections

Connection of the dual gradient system requires two refill valve kits and the gradient mixer package, as discussed in the introduction on Page 7-1.

The static mixer has an internal volume of 3.1 µl and pressure rating of 413.7 bar, and is supplied with PEEK Fingertight III fittings for connection to the 1/16" tubing in the kit.

> ☑ ***Note***
>
> The static mixer can be replaced by a user-supplied dynamic mixer.

Solvents are fed from each pump through the in-line filters and check valves, and into the static mixer, where they are mixed and fed into your system apparatus.

Kit components and connections are shown in Figures 7-3 and 7-4.

1. Connect the 10 cm length of 1/16" stainless steel tubing to the center port (outlet) of the mixer using the PEEK fittings provided.
2. Connect the other end of the tubing to the Valco valve at the port marked “P” (pump), using a Valco 1/16" nut and ferrule.
3. Connect the two in-line filters, oriented with flow toward the check valves (indicated by the arrow on the housing), one filter to each piece of 1/16" stainless steel tubing outlet from each pump.
4. Using the PEEK fittings, connect the 45.7 cm lengths of 1/16" stainless steel tubing to each inlet port on the mixer. Connect the other ends to the outlet fittings of the check valve assemblies.
5. Connect the two check valve inlets to the outlets of the in-line filters with the 12.7 cm lengths of tubing.
6. Press the check valves into the clips on the stand, as shown below, oriented with flow in the upward direction (indicated by the arrow on the housing).

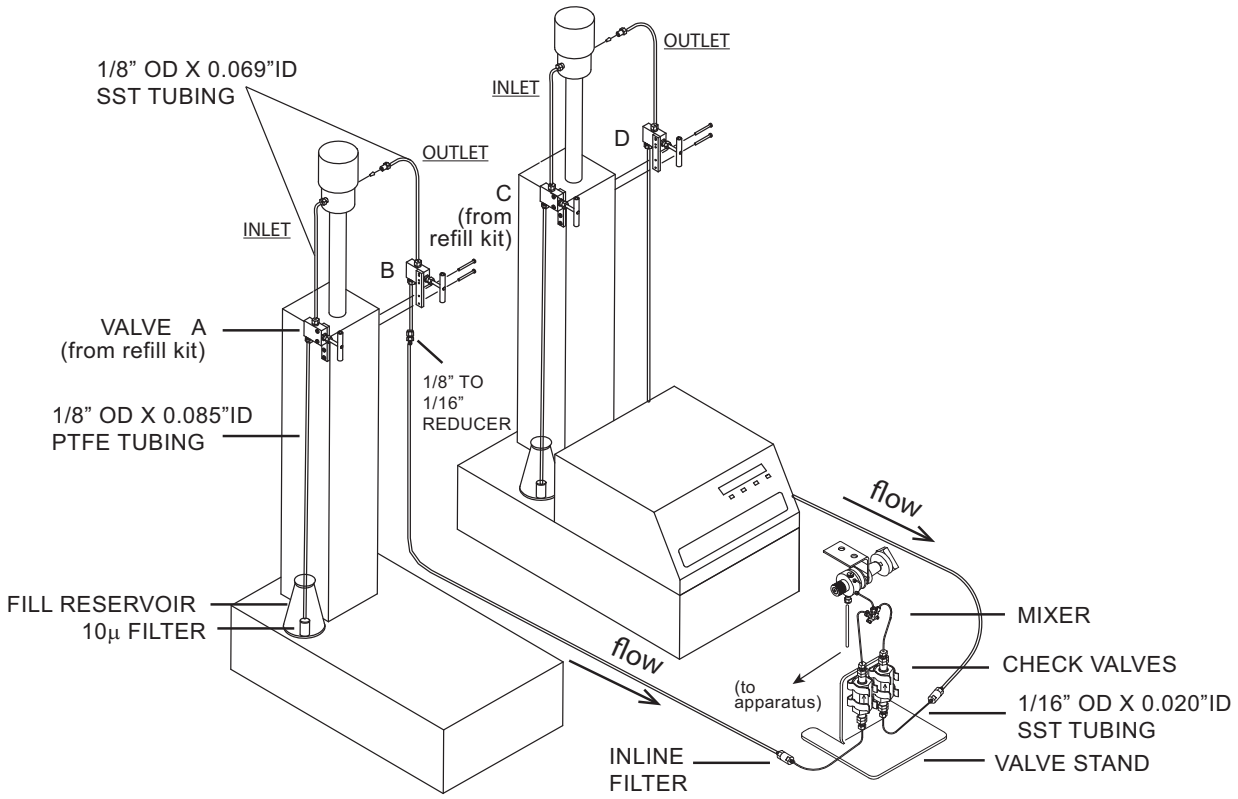


Figure 7-3 Dual gradient system connections
(Inlet valves (A & C) are from refill valve kits)

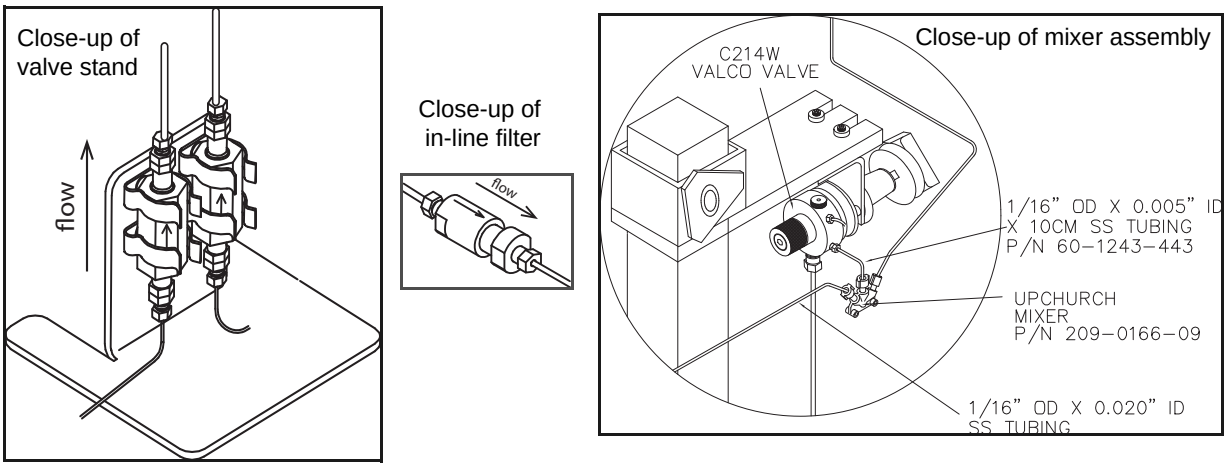


Figure 7-4 Dual gradient connections: Detail

7.3 Single-Pump Gradient Programming

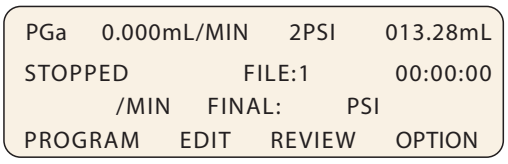
A single-pump gradient program is based on either pressure or flow, and controlled by either time duration (in minutes) or rate of change (units per minute).

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).

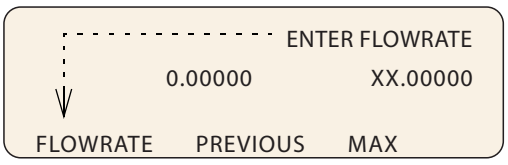
   The home screen will appear, with either PG (Pressure Gradient) or FG (Flow Gradient) in the upper left corner.



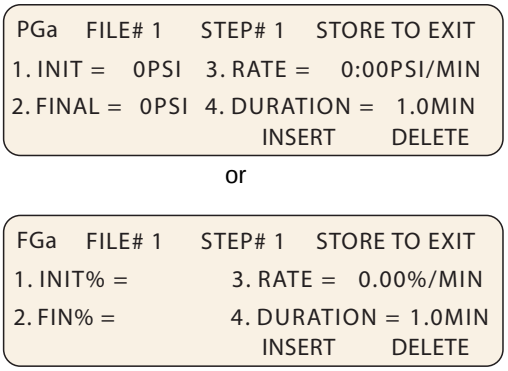
2. Press PROGRAM (A).
3. At the prompt, enter a file number between 1 and 99. This is the file name of your program, and can be the name of a new program you are creating, or a stored program you want to edit or run. Press ENTER.

> ☑ ***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.



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 7.5 *Review, Revise, & Hold Options*. When the last remaining step is deleted, the entire file is removed.

7.4 Dual Pump Concentration Gradient Programming

Two-pump concentration gradients enable proportionate use of two different fluids that combine at the mixer (refer to Figures 7-3 and 7-4).

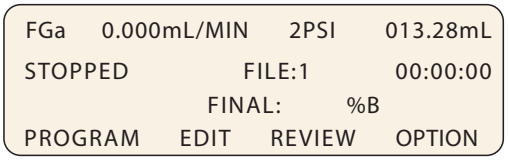
This type of pumping uses flow mode (FG) only. A single-pump gradient program is based on either pressure or flow, and controlled by either time duration (in minutes) or rate of change (units per minute).

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).

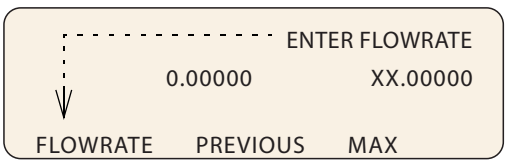
   The home screen will appear, with FG (Flow Gradient) in the upper left corner.



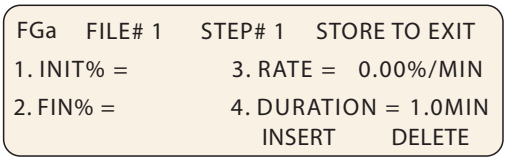
2. Press PROGRAM (A).
3. At the prompt, enter a file number between 1 and 99. This is the file name of your program, and can be the name of a new program you are creating, or a stored program you want to edit or run. Press ENTER.

> ☑ ***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, 7.5 *Review, Revise, & Hold Options*. When the last remaining step is deleted, the entire file is removed.

7.5 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.

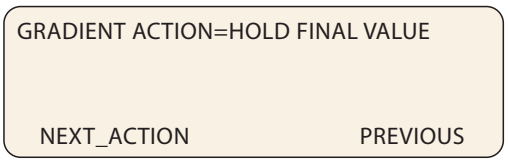
7.6 Program Conclusion

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.

D Series Syringe Pumps

Section 8 Continuous Flow Introduction, Installation, & Operation

8.1 Introduction

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

Continuous flow can be used in either of two modes: continuous constant pressure or continuous constant flow. Both of these modes assume positive displacement of the piston, with the exception of continuous Receive Mode (for detailed information about Receive Mode, refer to Technical Bulletin TB02, available on the Teledyne Isco web site).

In any syringe pump continuous flow system there is a flow irregularity which occurs at the time of switchover from one pump module to the other. This flow irregularity can be measured as a pressure fluctuation. 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.

The following sections provide part numbers, specifications, and installation steps for:

Continuous Flow Check Valves, on page 8-2

Continuous Flow Air Valves, on page 8-8

Continuous Flow Electric Valves, on page 8-13

User Supplied Valves, on page 8-16

Following these sections in the manual is information about:

Operation, on page 8-17

Operating Tips and Guidelines, on page 8-18

Special Features, on page 8-19

Accessories, on page 8-20

8.2 Continuous Flow Check Valves

The following section describes the installation procedure for continuous flow check valves.

> **☑ Note**
>
> Due to the higher operating pressure and special fittings, the model 65D pump requires hardware that is not listed in this section. Call the factory for details to configure a 65D pump for this type of operation.

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

8.2.1 Check Valve Technical Specifications

Dual system maximum flow rates under optimal conditions are approximately 65% of the max flow rate for each pump model.

Table 8-1 Continuous Flow Technical Specifications-Check Valves:

Pressure fluctuation at switchover	0.35 bar, at system backpressures from 6.9 bar to the single pump maximum. Higher fluctuation occurs at pressures below 6.9 bar.
Minimum	3.5 bar
Maximum system backpressure	The single pump maximum. Valves rated to 689.5 bar
Maximum flow rate (ml/min)	
Liquids: 65% of the single pump maximum rate.	C1000 265.2 C500 132.6 C260 69.55 C100X 32.50 C100M 16.25 C65DM 19.50
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:	
Check valves	SS316, sapphire, ruby, PEEK, PTFE
Tubing and fittings	SS316, gold

8.2.2 Dual Check Valve Installation

Check valve installation
(refer to Figure 8-1 or 8-2, depending on your pump model):

☑ Note

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

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

⚠ DANGER

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

3. Attach the connectors appropriate to your pump to the 6.4 cm unbent stainless steel tubing lengths and use the ⅛" nuts and ferrules to attach to the double check valve housings.
4. Attach the inlet tubing assembly. The tubing you use depends upon whether or not your source is pressurized.
   a. Pressurized Reservoir:
   Connect the ⅛" × 1.5 m stainless steel tubing to the bottom of the inlet tee, using high pressure valve fittings.

☑ Note

The filter and PTFE tubing are not used.

   b. Nonpressurized Reservoir:
   Connect the ⅛" × 1.5 m PTFE tubing to the bottom of each inlet check valve using the ferrule and nut with support spring provided in the package. Attach the tubing to the filter connector and then connect the filter.

☑ Note

The stainless steel tubing is not used.

5. Once the contents of the continuous flow package are totally assembled, attach the connectors appropriate for your pump on one side of the assembly to a port. Then, supporting the tee/valve assembly attach the other connector to the port of the second pump.
6. Attach the outlet fittings to the top of the upper tee. Fittings for ⅛" tubing, as well as an optional reducing fitting

for 1⁄16" tubing, are provided. Use the fittings appropriate for your tubing size.

7. Tighten all fittings.

8.2.3 Inlet Tubing

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

⚠ DANGER

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

☑ *Note*

The fittings for connection to pressurized source are not provided. A CO_2 cylinder connection package (P/N 68-1247-043) is available. Refer to section 2A.3.2 of the Instruction Manual.

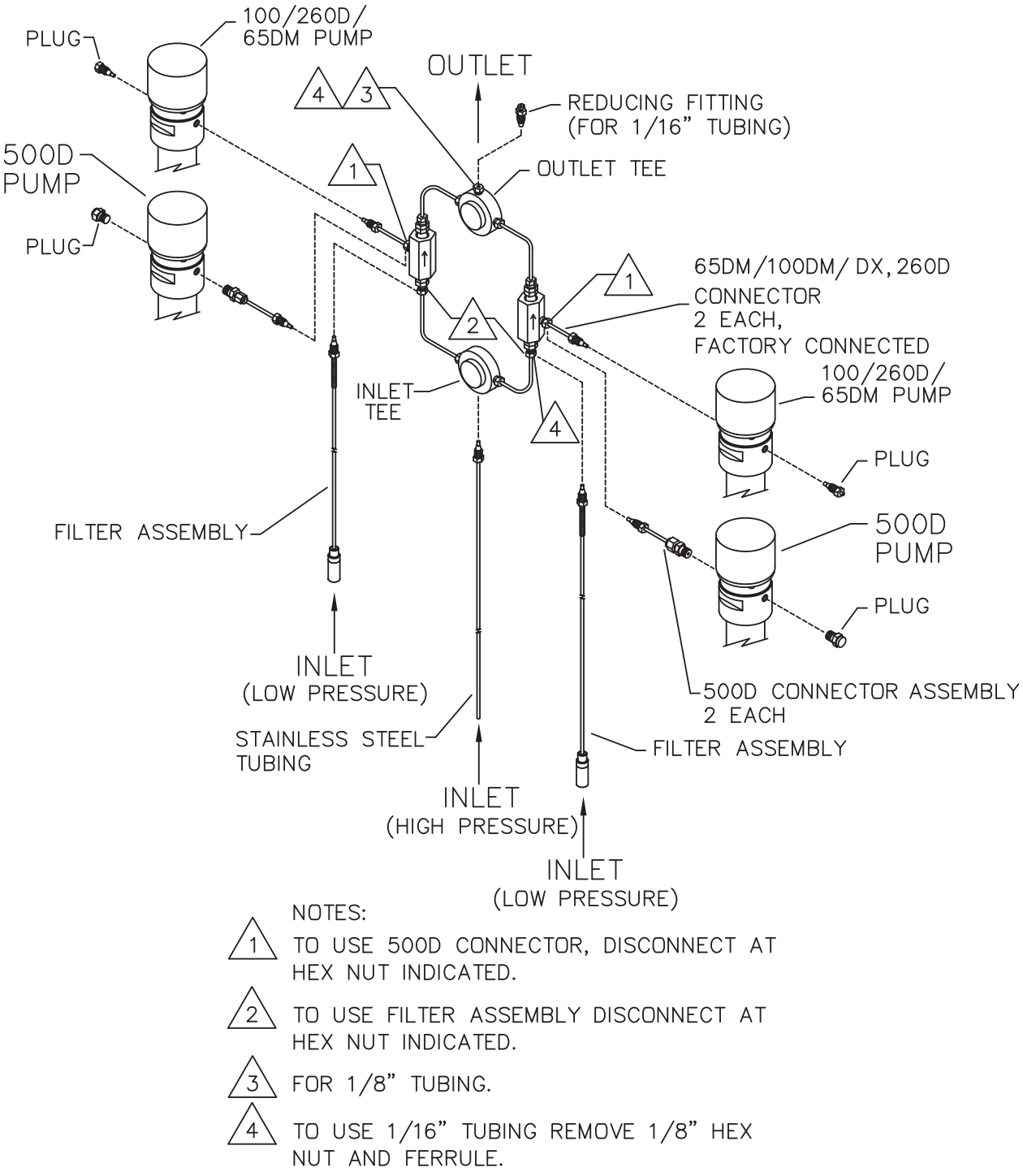


Figure 8-1 Check valve package installation: 65DM / 100D / 265D / 500D pumps

Table 8-2 Continuous Flow Check Valve Package for 100D/260D /500D, part #68-1247-059

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

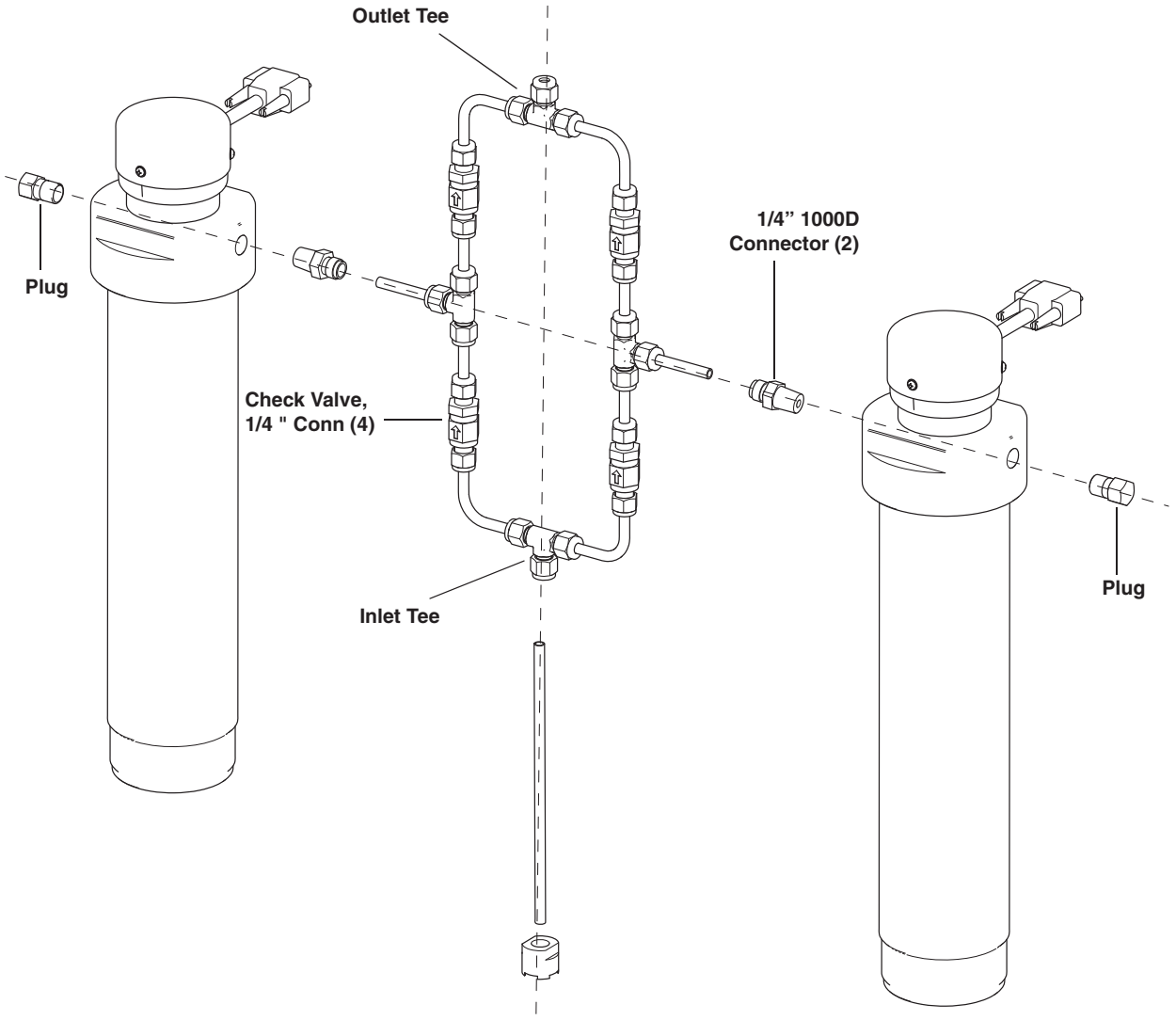


Figure 8-2 Check valve package installation: 1000D pump

Table 8-3 Continuous Flow Check Valve Package for 1000D, part #68-1247-128

Qty.	Part Number	Description
24"	004-7302-251	SST tubing .250 x .035
6	60-1243-893	Valve-to-pump tubing
2	209-0163-36	Male connector, 1/4" tube OD to 1/4" NPT
4	209-0164-06	Check Valve w/ 1/4" tube connections
4	209-0168-15	Tee union, 1/4" tube OD
4	60-1243-936	2" x 2" SST tubing elbow

8.3 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

A1000	68-1247-104
A500	68-1247-061
A65DM, A260, A100M, A100X	68-1247-058
A65	68-1247-129

Table 8-4 Continuous Flow Technical Specifications-Air Valves:

Pressure fluctuation at switchover	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.	A1000 265.2 A500 132.6 A260 69.55 A100X 32.50 A100M 16.25 A65DM 19.50 A65 16.25
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
Check valves	SS316, sapphire, ruby, PEEK, PTFE
Tubing and fittings	SS316, gold

8.3.1 Dual Air Valve Installation

To install the air valve package (refer to Figure 8-3, 8-4, or 8-5, 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; place the straps around the pressure transducer caps. Tighten the wing-nuts.
5. Install the four panhead screws on bottom of the bracket.

Plumbing connections

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

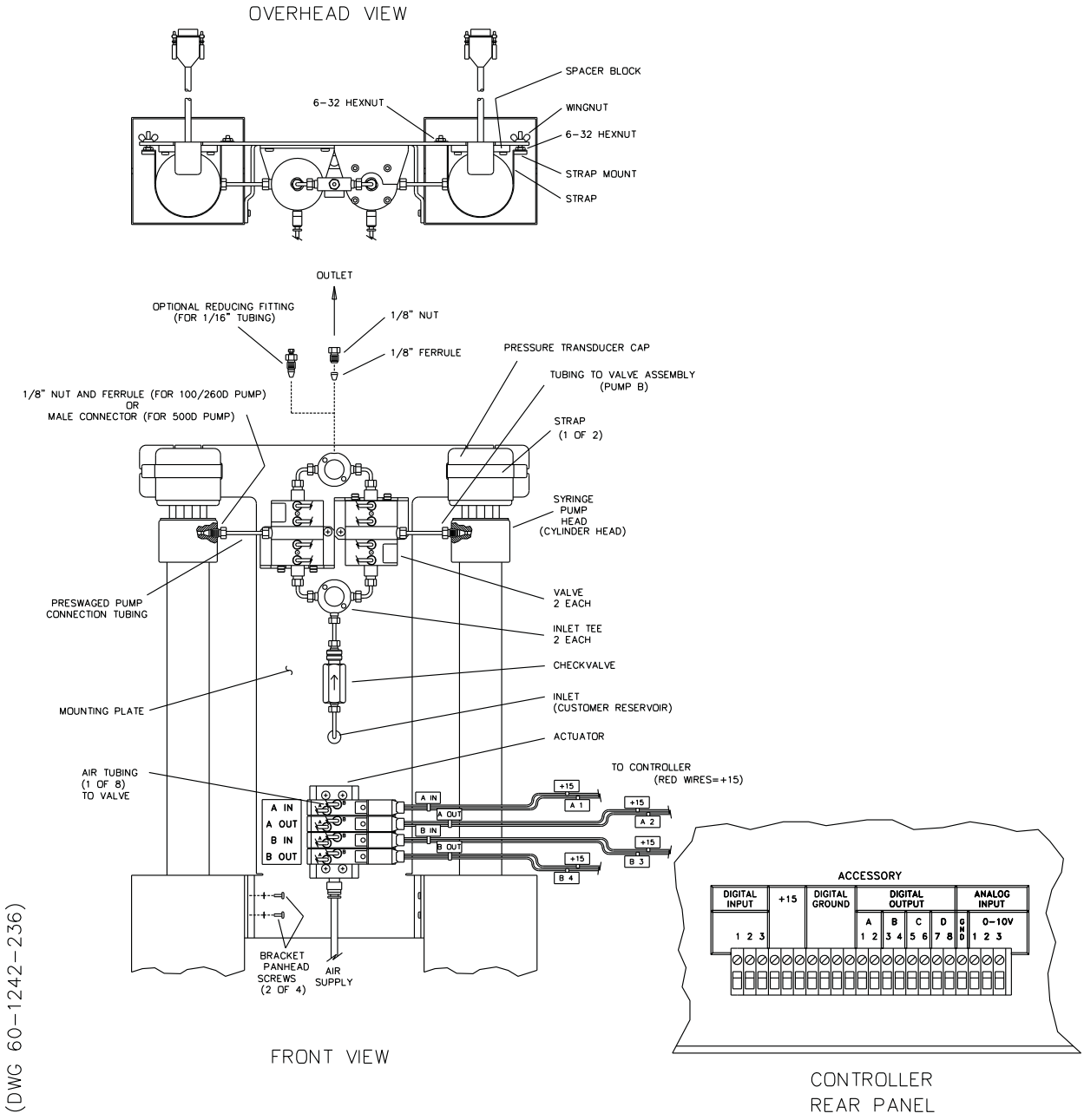


Figure 8-3 Air valve installation for 65DM, 100DM/DX, 260D, and 500D pumps

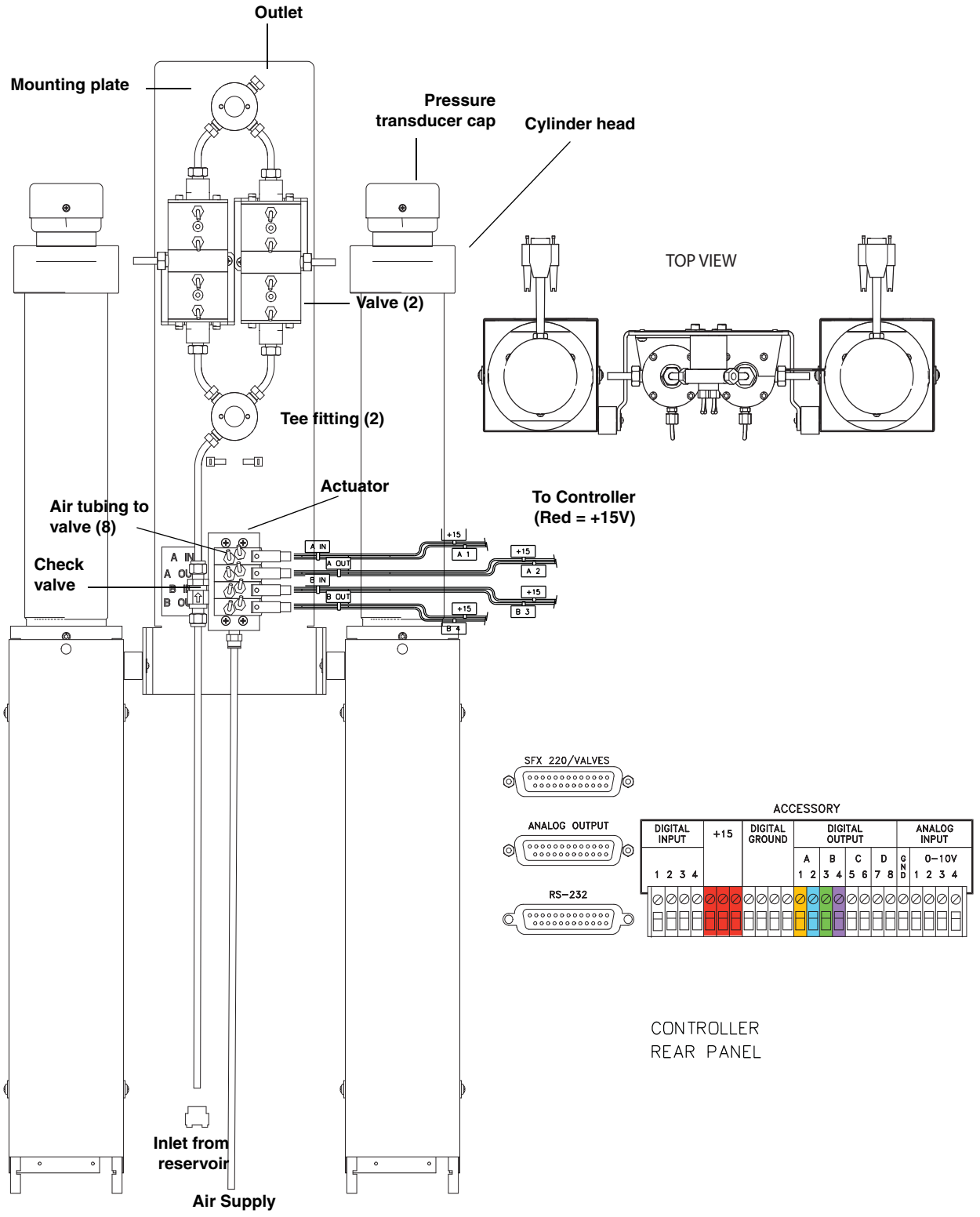


Figure 8-4 Air valve installation for 1000D pump

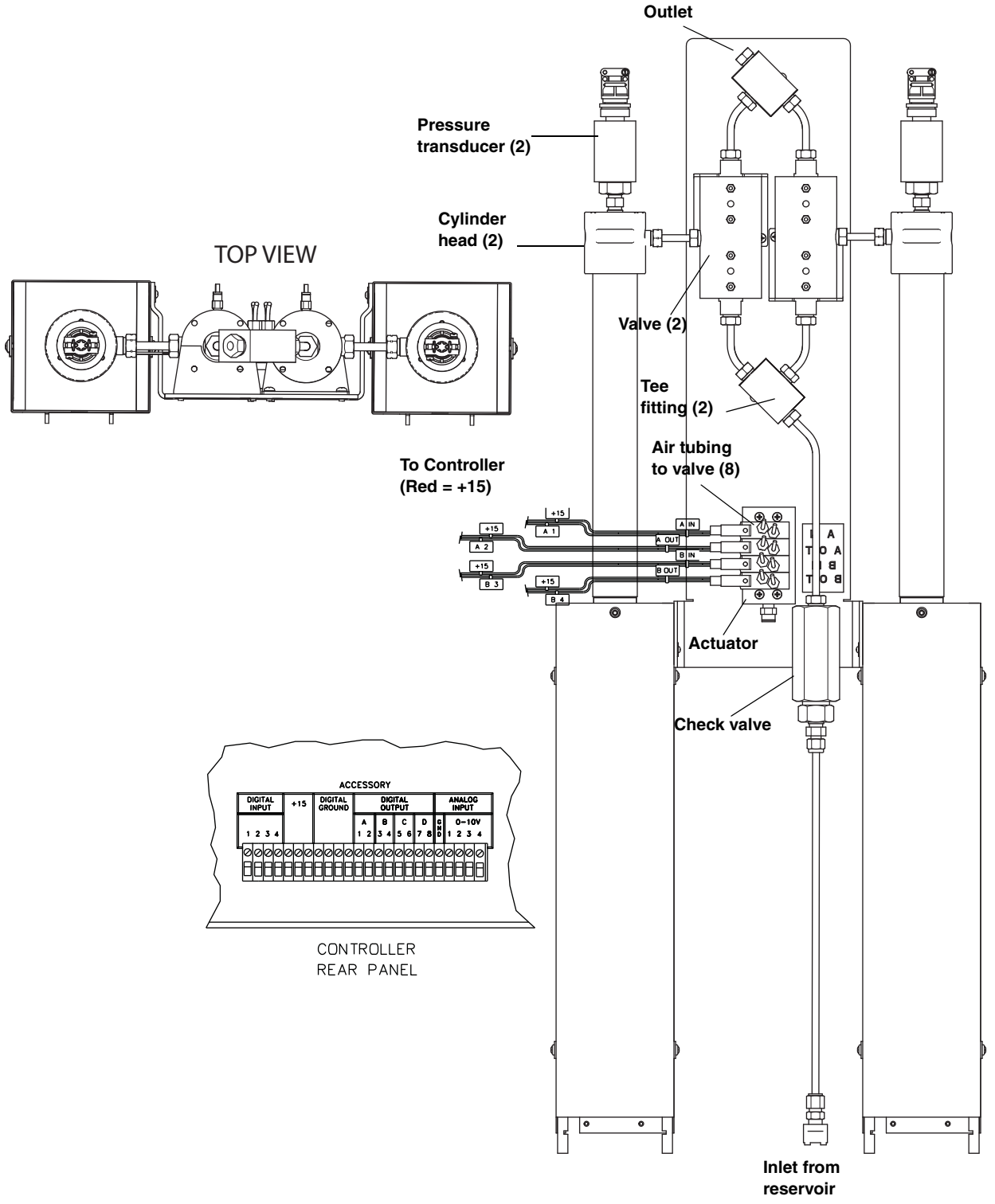


Figure 8-5 Air valve installation for 65D pump

8.4 Continuous Flow Electric Valves

Electric valves, which provide the best positive valve closure, are most commonly used in liquefied gas applications. Electric valves require the pump controller to be equipped with the valve driver board.

> ☑ ***Note***
>
> The max flow rate for the **E1000** dual system will tend to have a lower percentage flow rate due to port size restrictions, with a maximum flow rate equal to that of the **E500** system (see Table 8-5).

Electric Valve Package Numbers

E1000	68-1247-109
E500	68-1247-091
E260, E100M, E100X	68-1247-090

> ☑ ***Note***
>
> Electric valves are not available for the **65D** pump. Please consult the factory for options.

8.4.1 Technical Specifications

Dual system maximum flow rates under optimal conditions are approximately 65% of the max flow rate for each pump model.

Table 8-5 Continuous Flow Technical Specifications-Electric Valves:

Pressure fluctuation at switchover	0.35 bar, at system backpressures from 6.9 bar to the single pump maximum. Higher fluctuation occurs at pressures below 6.9 bar.
Minimum	3.5 bar
Maximum system backpressure	The single pump maximum. Valves rated to 689.5 bar
Maximum flow rate (ml/min)	
Liquids: 65% of the single pump maximum rate (excluding E1000 systems).	E1000 132.6 E500 132.6 E260 69.55 E100X 32.50 E100M 16.25 E65DM 19.50
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:	
Check valves	SS316, sapphire, ruby, PEEK, PTFE
Tubing and fittings	SS316, gold

8.4.2 Dual Electric Valve Installation

To install the electric valve package (refer to Figure 8-6):

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

⚠ DANGER

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

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

Plumbing connections

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

Electrical connections

8. Connect the DB-25 cable to the controller rear panel “SFX 220/VALVES” connector (Figure 8-6).

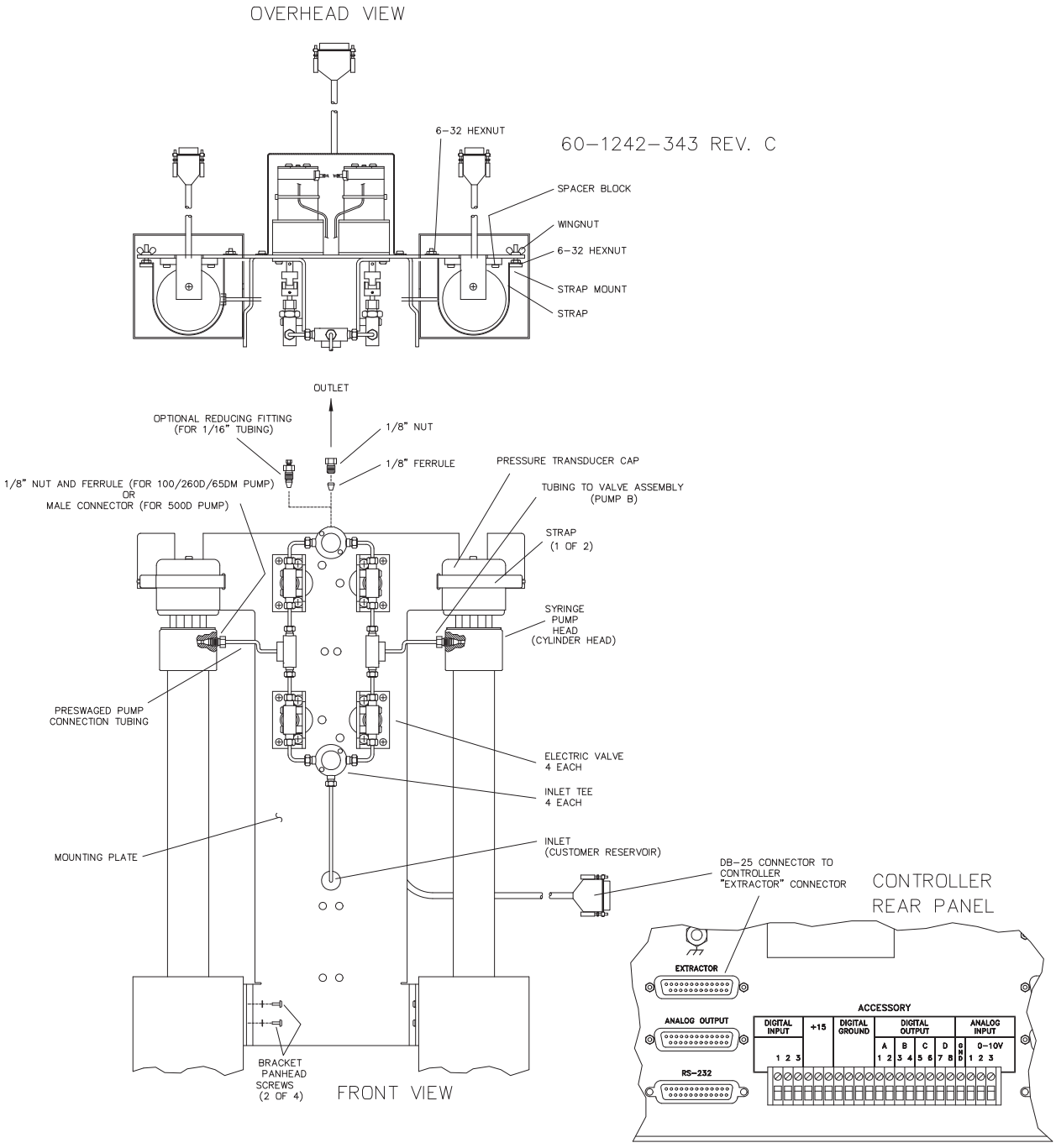


Figure 8-6 Electric valve installation

8.5 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.

Table 8-6 presents the relationship between the digital output, pump valve location and the fluid path status for the "ACCESS CTRL" connections. Refer to the accessory control connections on the rear panel of the pump controller.

Table 8-6 Accessory Control Digital Outputs

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

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

8.6 Operation

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

> ☑ ***Note***
>
> 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 the "ACCESS CTRL" key. Lights on the air switches indicate which valves are open.

8.6.1 Continuous Flow Setup

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

To set up continuous constant flow

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

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

To set up continuous constant pressure

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

The controller is now set to continuous constant pressure mode.

8.6.2 Continuous Flow Features

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

Volume Totalizer

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

To reset the volume totalizer to zero

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

Valve Specification

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

To specify valves installed

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

8.7 Operating Tips and Guidelines

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

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

Operational Overview – When using liquids

1. Degas liquids if appropriate.
2. Fill both pumps completely.

3. Zero pressure in each pump (requires valves open to atmosphere).
4. Purge air.
5. Perform the total volume reset operation, as previously described.
6. Be sure “ON CONT FLOW” is displayed on the screen.
7. When the pumps start delivering, the system will go through an equilibration phase. To properly equilibrate the pumps, they must be full and delivering fluid during equilibration phase.
8. Press RUN.

Operational Overview – When using liquefied gases

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

8.8 Special Features

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

8.8.1 Remote Start/Stop

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

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

8.8.2 External Analog Control

Flow or pressure setpoints can be externally controlled by analog voltage. Two wires are required for analog control. The analog common or ground wire should be connected to the GND terminal under ANALOG INPUT, and the analog control signal (or input) should be connected to terminal 1 under ANALOG INPUT. For more information, see section 3.7 of this instruction manual.

8.8.3 Serial Control and Monitoring

The pumps can be externally controlled with a computer which has an RS-232-C serial output. The serial interface accepts English command words from the computer, like constant pressure, refill, etc. For more information, see Section 6, Serial Interface.

8.9 Accessories

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

Temperature control jacket part numbers

1000D	68-1247-115
500D	68-1247-057
65D, 100DM/DX, 260D	68-1247-047

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

For information on other accessories please contact Teledyne Isco at:

(800) 228-4373 or (402) 464-0231

or

IscoInfo@teledyne.com

D Series Syringe Pumps

Section 9 Modifier Addition

9.1 Introduction

The Teledyne Isco modifier addition systems utilize two D Series syringe pumps regulated by one controller to deliver a mixture of supercritical fluid and modifier to one or more Model SFX 2-10, SFX 220, or SFX 3560 extractors.

> **☑ Note**
>
> The configurations described in this section apply to 65DM, 100DM, 100DX, 260D, 500D, and 1000D pumps that use Valco or SSI fittings.
>
> The 65D pump can be configured and operated in a similar manner. However, due to the higher operating pressure and the AE F250C fittings, the 65D requires hardware that is not listed in this section. Call the factory for details to configure a 65D pump for this type of operation.

Pump A delivers supercritical fluid while pump B meters modifier. Both fluids pass through one-way check valves before they meet and are blended together in a mixing tee. Modifier concentrations of up to 100 percent (v/v) are programmable via the controller. If higher concentrations are needed, put the modifier in pump A to be delivered as the primary fluid.

Both pumps operate in constant pressure mode and will flow up to their maximum rate to maintain the set pressure. When modifier addition mode is selected and the RUN key is pressed, pump A pressure is ramped at its maximum flow rate to the set pressure while pump B waits at a lower pressure (3.5 bar).

The user can increase the pump B minimum pressure if the modifier boils at room temperature and 3.5 bar. See Section 9.4, Modifier Addition.

Once pump A has reached the set pressure, the controller will enter a hold mode and wait for a pressure drop, with opening the extractor inlet to signal the start of “EQUILIBRATION,” or the user can press the “RUN” key to start equilibration.

> **☑ Note**
>
> Flow must then be started through the system by opening all valves! The modifier pump will not equilibrate properly without flow.

Then pump B pressure is slowly ramped upward until its check valve is detected to open. At this point, the controller exits “EQUILIBRATION” mode and displays the message “RUNNING” on the front panel display.

When "RUNNING" is displayed, the controller monitors pump A piston movement and calculates the pump B piston movement required to deliver the correct ratio of modifier. If pump A cannot maintain the set pressure, as when the extraction cartridges are initially filling or pump A is refilling, the controller reverts to 'EQUILIBRATION" and pump B pressure is dropped below that of pump A to avoid delivery of incorrect modifier concentrations. Once the pump A set pressure is reestablished, the system will re-equilibrate.

When pump B needs refilling, it must first be placed under independent control as you must run it to return 5-10 ml of modifier back through the valve to be sure that the cylinder is free of air.

> ☑ ***Note***
>
> To properly equilibrate the pumps, they must be delivering fluid.

9.2 Plumbing Kit for Modifier Addition

The modifier addition kit (P/N 68-1247-079) is detailed in Table 9-1. This package is used to connect the outlets of two pumps together, using a Valco 1⁄16" tee as a mixer.

Table 9-1 Modifier Addition Kit (P/N 68-1247-079)

Part Number	Description
209-0169-47	Tee union fitting
60-1243-540	1⁄16" OD × 12 cm tubing
209-0169-34	1⁄16" Ferrule
209-0169-35	1⁄16" Gland nut
60-2253-209	Standard check valve housing
60-3864-010	Check valve cartridge
60-1243-516	Single check valve housing
209-0169-41	1⁄8" Ferrule, zero vol
209-0169-27	1⁄8" nut
60-1243-539	1⁄16" OD × 1.5 m tubing
60-1243-659	Valve spacer
209-0098-05	2-way valve - 1⁄8" OD
60-1243-658	Tubing, valve inlet
60-1243-644	Tubing, check valve
209-0162-10	Reduction union
60-1243-570	Tubing
209-0161-80	Check valve cartridge
60-1243-691	Check valve/mixer tubing
Appropriate screws and washers also included.	

The mixing tee union fitting, check valves, and pre-bent SST tubing comes assembled so that you can quickly and easily install it in your system, refer to Figure 9-1.

For additional convenience, this package is pre-assembled. The only connections you have to make are to the pump outlet ports and the outlet tubing from the tee (not provided).

The PTFE tubing (P/N 023-0504-02) and filter (P/N 209-9012-10) from refill kit should be connected to the inlet valve of pump B.

To install the modifier addition kit

⚠ DANGER

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

1. Attach a 2-way valve to each pump housing, using the spacer block and screws.

☑ *Note*

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

2. Attach the pump outlet tubing/2-way valve assembly to each pump outlet.
3. Attach the 10.2 cm pre-bent SST tubing from the check valve inlet to the 2-way valve outlet.
4. Connect your tubing from the tee outlet to your equipment.

☑ *Note*

Tubing for connection to user equipment is not provided. Optional 1⁄16" and 1⁄8" OD stainless steel tubing may be ordered through Teledyne Isco, see optional accessories sections 2A.8 and 2B.6.

All fittings may now be retightened.

⚠ DANGER

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

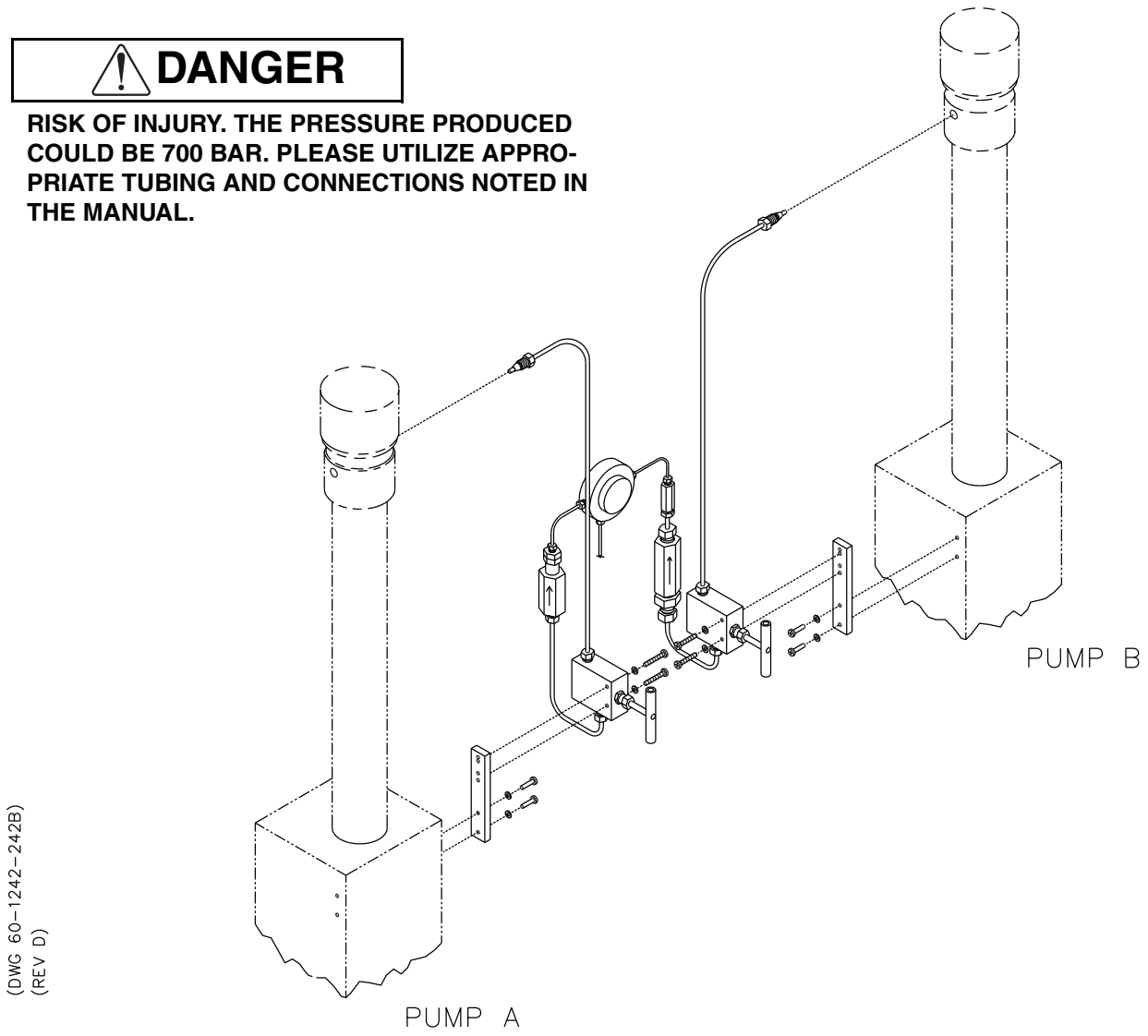


Figure 9-1 Modifier addition kit installation

☑ *Note*

Figure 9-1 shows the two pumps with the refill kits installed. The instructions for this are provided in sections 2A.3.1 and 2B.3.1 (Figure 2A-4). When preparing your system for modifier operation, if you are connecting pump A to a CO_2 tank, you will need to use the stainless steel tubing (P/N 60-1243-391) and appropriate CO_2 connecting fittings. If you do not have these fittings, a CO_2 cylinder connection package (P/N 68-1247-043) may be ordered from Teledyne Isco.

9.3 Initial Preparation for Modifier Addition

When first setting up the D Series pump system under modifier mode, the pumps should be zeroed and filled. To accomplish this, the pumps should first be placed under independent control - constant pressure mode.

> **☑ Note**
>
> Once the modifier system is operating, the system does not need to be zeroed before refilling.

To designate independent control (constant pressure mode)

1. If the pumps are running, press the STOP key once.
2. Press the MENU key.
3. Press softkey A - MORE.
4. Press 4 - MULTI-PUMP, to display the multi-pump menu.
5. Press 4 - INDEPENDENT to designate that the pumps be operated under independent control. The number 4 will blink, indicating that independent has been selected.
6. Press softkey D - PREVIOUS, twice to return to the main menu.

To designate constant pressure

1. Press the blue CONST PRESS key on the front panel keypad.

To zero the pumps

1. Place the pumps in independent control - constant pressure mode, as detailed above.
2. Be sure the pumps are stopped.
3. Disconnect the inlet tubing from the inlet valve of pump A.
4. Select 2 pump independent control/constant pressure mode.
5. Open the inlet valves of each pump.
6. Run both pumps to their empty positions.
7. Zero the pressure on each pump.
8. Reconnect the pump A inlet tubing to the inlet valve.

To fill pump B with modifier

1. Place the pumps in independent control - constant pressure mode, as detailed above.
2. Be sure the pumps are stopped.
3. Close the pump B outlet valve and open the pump B inlet valve.
4. Press the REFILL key on the front panel keypad. Press softkey B to designate that pump B is the active pump (the pump being refilled). Pump B will fill with modifier.
5. After pump B has filled, press run and deliver 5-10 ml of modifier back through the inlet valve, to ensure all air is purged from the pump, before pressing stop.
6. Close the inlet valve.

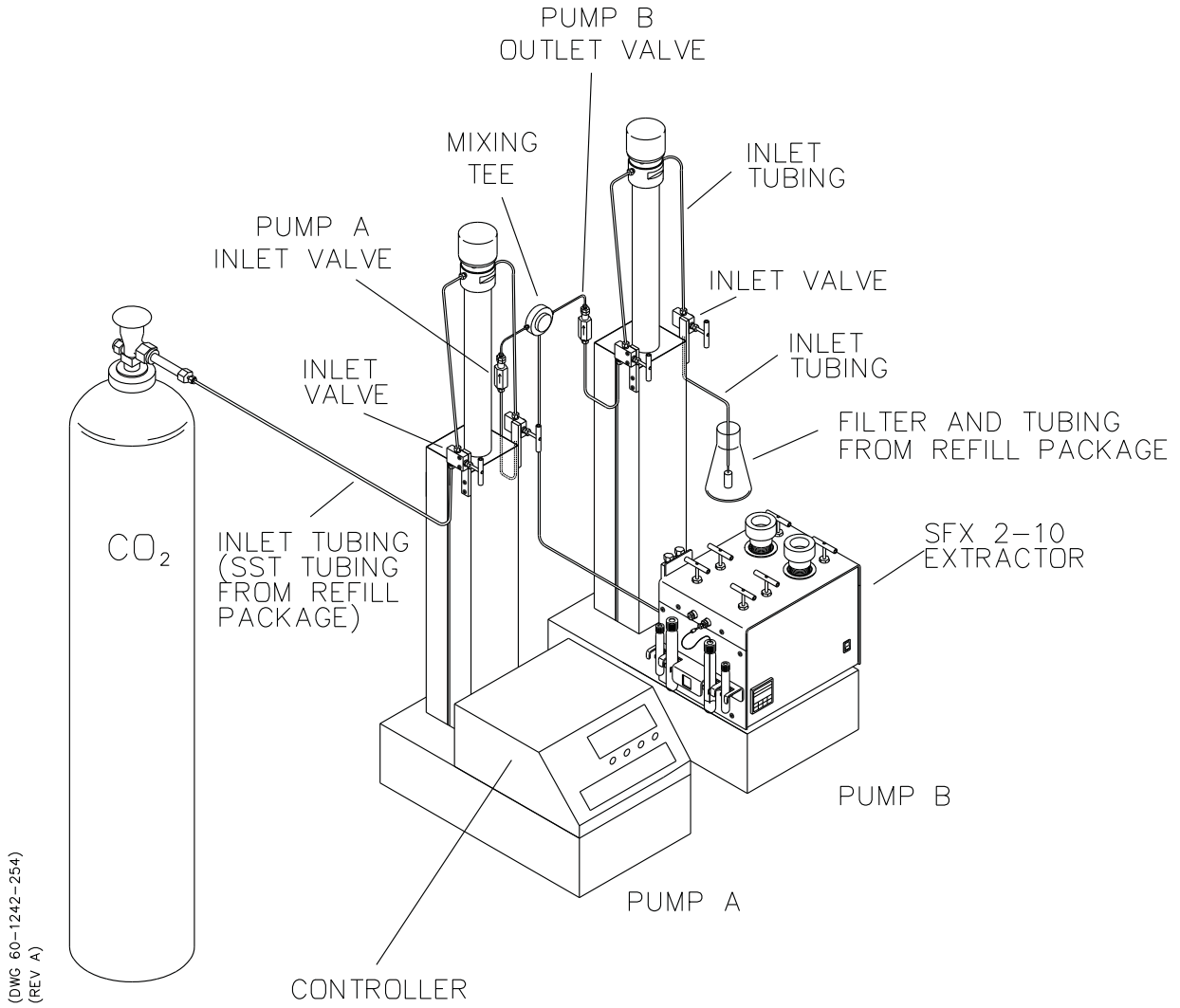


Figure 9-2 Two pump modifier system

☑ Note

Make sure you purchase a "dip-tube" CO_2 tank.

To fill pump A with supercritical fluid (helium head-space tank)

1. Place the pumps in independent control - constant pressure mode, as detailed above.
2. Be sure the pumps are stopped.
3. Close the pump A outlet valve before opening the tank supply valve and pump A inlet valve.
4. Press the REFILL key on the front panel keypad. Press softkey A to designate that pump A is the active pump (the pump being refilled). Pump A will fill with pressurized fluid.

5. After pump A has refilled, wait 15 seconds before closing the tank supply valve and pump A inlet valve.

9.4 Modifier Addition

Once the pressure has been zeroed and both pumps are filled, you are ready to set up your modifier addition parameters. You will need to place the pumps in modifier mode, set the pressure limits (under the limits option on the main menu) and designate the percent of modifier (found under % pump on the run screen) to be added. If your modifier boils at 3.5 bar at room temperature, you may want to increase the minimum pressure for pump B to prevent vapor (the default minimum pressure is 3.5 bar).

To select modifier mode

1. Press the orange MENU key and press softkey A - MORE.
2. Select 4, MULTI-PUMP, to access the multi-pump menu.
3. Then select MODIFIER by pressing the 3 on the numeric keypad. The 3 will begin to blink, indicating that modifier mode has been selected.
4. Press softkey D, PREVIOUS, three times to return to the main menu.

To change the minimum modifier pressure

1. Press the orange MENU key and press softkey A - MORE.
2. Select 4, MULTI-PUMP, to access the multi-pump menu.
3. Then select MIN MOD PRESS by pressing the softkey B.
4. To change the minimum modifier pressure, press the softkey B and enter the desired minimum pressure using the numeric keypad and press the ENTER key to store the value.
5. Then press softkey D, again, to return to the multi-pump menu.

To select the limits

1. Once modifier mode has been selected, the desired pressure limits must be set. Select number 2, LIMITS, from the main menu.
2. The pump for which the limits are being set will be shown on the top left of the display, LIMITS: PUMP A. If it is any pump other than pump A, press softkey A. LIMITS: PUMP A will then be displayed.
3. Press number 1 to select limits and then 1 again to set the MAX pressure limits. Enter the desired maximum pressure using the numeric keypad and press the ENTER key to store the value. Then press softkey D, PREVIOUS, to return to the limits menu.
4. If you need to change the minimum pressure limit, press 2 - MIN. Enter the desired minimum pressure using the numeric keypad and press the ENTER key to store the value.
5. Press softkey D, PREVIOUS, to return to the limits menu.
6. Then press softkey D, again, to return to the main menu, and D, again, to return to the run screen.

7. MODIFIER ON will be displayed above softkey B, and % PUMP will be displayed above softkey C. To designate the desired modifier concentration, press softkey C. Then use the numeric keys to enter the desired percentage of modifier. Press the enter key to save the desired value.
8. Open the outlet valves of both pumps if they are not open.
9. Press the RUN key on the controller front panel keypad.
10. When A pressure is established, the message "HOLD: PRESS RUN" will be displayed.
11. Open the extractor inlet valves.
12. The message "EQUILIBRATE" will be displayed on the controller screen. If the controller does not display "EQUILIBRATE," press the RUN key. While this message is displayed, no modifier will be delivered.
13. Immediately open the extractant outlet valve(s).

☑ Note

Flow MUST be established through the system at or before the time "EQUILIBRATE" is displayed. To properly equilibrate the pumps, they must be delivering fluid.

14. Once the message "Running" is displayed, modifier will be delivered at the selected rate.

9.5 Refilling

Once your modifier addition system is running, you will occasionally need to refill the pumps. The system must be stopped while the pumps are refilling. Pump A, the "CO_2" pump, may be refilled simply by designating the pump to be refilled and then pressing the REFILL key on the front panel (refer to instructions below). Pump B, "the modifier pump", may also be refilled in this manner. However, if you wish to ensure that air is purged from pump B, it must be placed under independent control before refilling. Once under independent control, the pump will run until 5-10 ml of modifier are delivered back to the source (see refilling pump B below).

To refill pump A (the CO_2 pump)

1. Press the STOP key.
2. Close the outlet valves of both pumps.
3. Press the REFILL key, and press softkey A to designate pump A.
4. As soon as the pump pressure drops below the known tank pressure, open the tank supply valve and the pump A inlet valve.
5. After pump A has refilled, the message "cylinder full" will be displayed on the controller front panel. Wait 15 seconds before closing the tank supply valve and the pump A inlet valve.
6. Open the outlet valves of both pumps if they are not open.
7. Press the RUN key on the controller front panel keypad.

8. When A pressure is established, the message “HOLD: PRESS RUN” will be displayed.
9. Open the extractor inlet valves.
10. The message “EQUILIBRATE” will be displayed on the controller screen. If the controller does not display “EQUILIBRATE,” press the RUN key. While this message is displayed, no modifier will be delivered.
11. Immediately open the extractant outlet valve(s).

> **☑ Note**
>
> Flow MUST be established through the system at or before the time “EQUILIBRATE” is displayed. To properly equilibrate the pumps, they must be delivering fluid.

12. Once the message “Running” is displayed, modifier will be delivered at the selected rate.

To refill pump B (the modifier pump)

1. Press the STOP key.
2. Close the outlet valves of both pumps.
3. Take the pumps out of modifier mode by pressing softkey B under the words “MODIFIER”. The word ON will change to OFF above the modifier.
4. Open the inlet valve of pump B.
5. Press the REFILL key, and press softkey B to designate Pump B.
6. After pump B has filled, press the CONST FLOW key and set the desired purging flow rate. Press the RUN key and deliver 5-10 ml of modifier back through the inlet valve. This ensures that all air is purged from the pump.
7. Press the red STOP key on the controller front panel keypad. Then press softkey B.

To start modifier

1. Return to constant pressure mode by pressing softkey D, “SELECT PUMP,” and then softkey A.
2. Place the pump in modifier mode by pressing softkey B under the words “MODIFIER.” The word OFF will change to ON above “MODIFIER.”
3. Open the outlet valves of both pumps if they are not open.
4. Press the RUN key on the controller front panel keypad.
5. When A pressure is established, the message “HOLD: PRESS RUN” will be displayed.
6. Open the extractor inlet valves.
7. The message “EQUILIBRATE” will be displayed on the controller screen. If the controller does not display “EQUILIBRATE,” press the RUN key. While this message is displayed, no modifier will be delivered.
8. Immediately open the extractant outlet valve(s).

> **☑ Note**
>
> Flow MUST be established through the system at or before the time EQUILIBRATE is displayed. To properly equilibrate the pumps, they must be delivering fluid.

9. Once the message "Running" is displayed, modifier will be delivered at the selected rate.

9.5.1 Remote Start/Stop

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

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

9.5.2 External Analog Control

The pumps can be externally controlled by analog voltage. Two wires are required for analog control. The analog common or ground wire should be connected to the GND terminal under ANALOG INPUT and the analog control signal (or input) should be connected to terminal 1 under ANALOG INPUT. For more information, see section 3.7 of the instruction manual.

9.5.3 Serial Control

The pumps can be externally controlled with any IBM-PC or compatible which has RS-232-C serial output. The serial interface accepts English command words from the computer like constant pressure, refill, etc. For more information, see Section 6, Serial Interface.

D Series Syringe Pumps

Appendix A Replacement Parts

A.1 Replacement Parts

Replacement parts are called out in the following illustrations. Refer to the call-out in the adjacent table to determine the part number for the item.

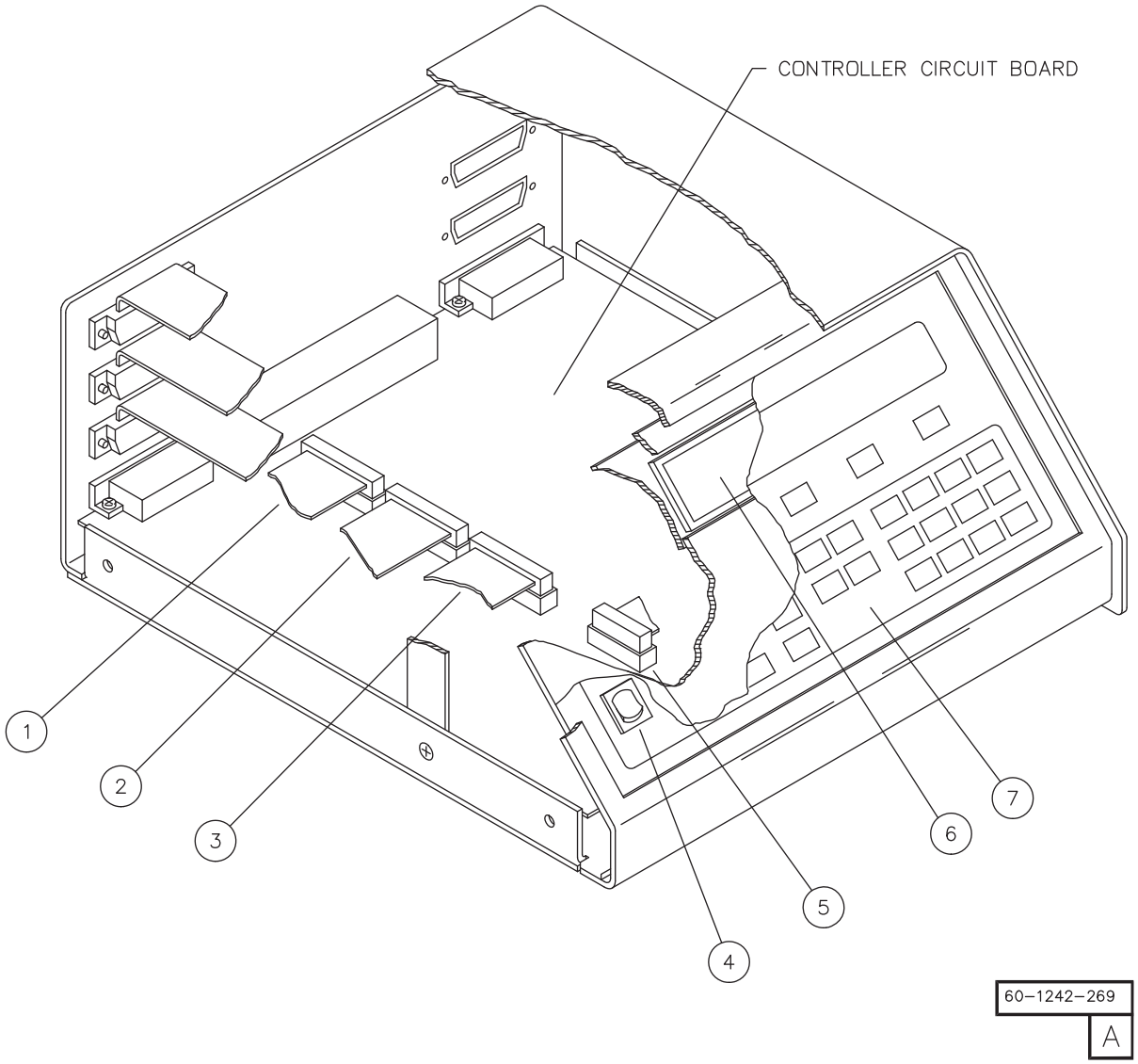
Replacement parts can be purchased by contacting Teledyne Isco's Customer Service Department.

Teledyne Isco
Customer Service Department
P.O. Box 82531
Lincoln, NE 68501 USA

Phone: (800) 228-4373
(402) 464-0231
FAX: (402) 465-3022

E-mail: IscoInfo@teledyne.com

A.1.1 D Series Controller



REPLACEMENT PARTS LIST

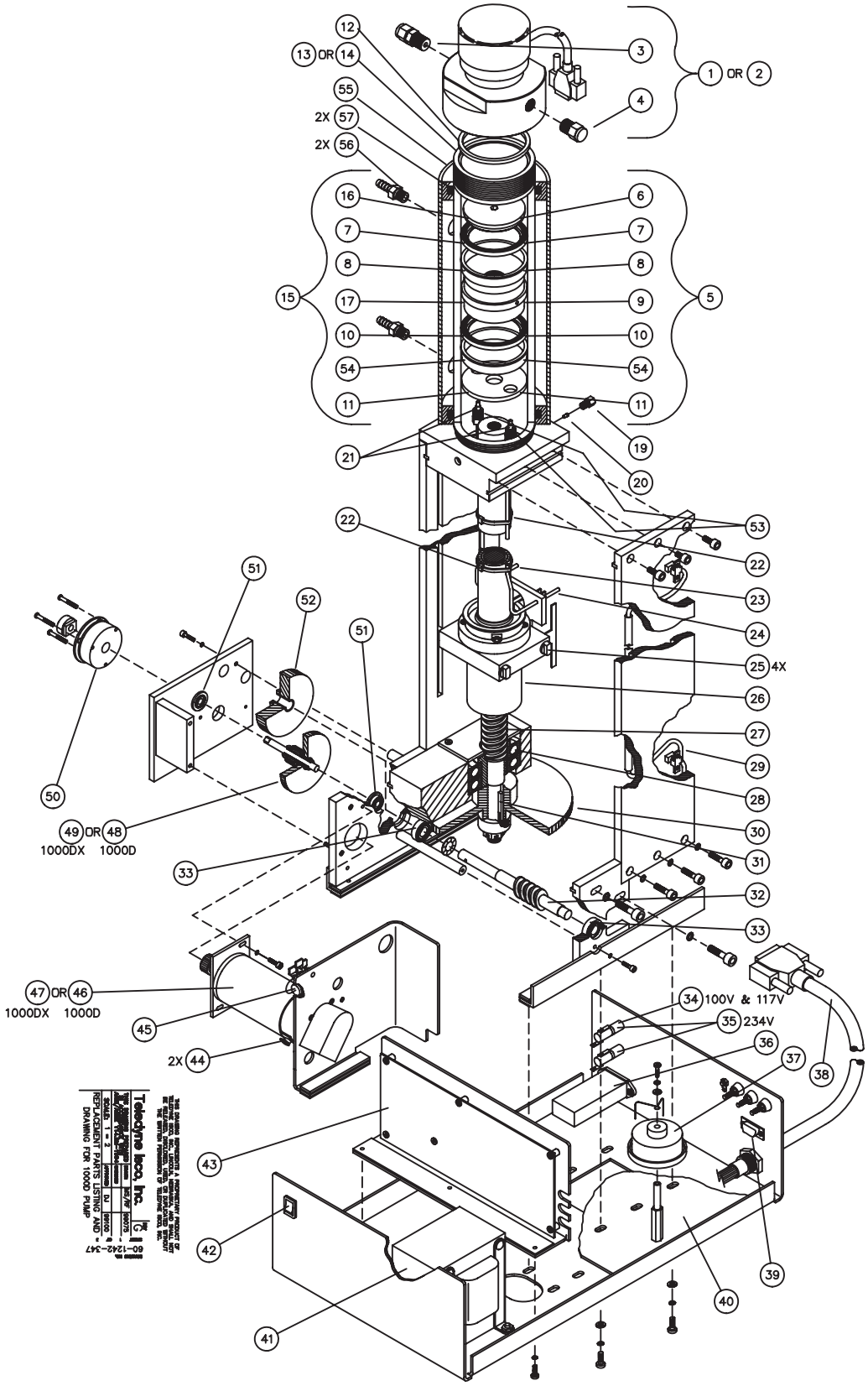
Isco, Inc. Syringe Pump Controller

DWG. NO.: 60–1242–269
SHEET: 2 OF 2
REV.: A DATE: 03180

ITEM NO.	PART NUMBER	DESCRIPTION
1	60–1244–230	CABLE ASSY
2	60–1244–232	CABLE ASSY
3	60–3934–015	CABLE ASSY
4	60–1244–263	SWITCH ASSY
5	60–1244–231	CABLE ASSY
6	60–1244–229	DISPLAY ASSY
7	69–1243–429	FRONT PANEL LABEL

Note: 1. For current prices and quotations on parts, contact Isco Customer Service Department.
2. This list is subject to change without notice.

A.1.2 1000D Pump



REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–347
SHEET: 2 OF 3
REV.: G DATE: 073109

ITEM NO.	PART NUMBER	DESCRIPTION
1	60–1244–334	PREAMP ASSY, NITRONIC
2	60–1244–335	PREAMP ASSY, HASTELLOY
3	209–0163–36	CONNECTOR, 1/4 TO 1/4 NPT, 316 STAINLESS STEEL
4	209–0168–09	PIPE PLUG, 1/4 NPT, 316 STAINLESS STEEL
5	60–1244–326	1000ml PISTON ASSY, NITRONIC
6	60–1243–772	1000ml SEAL RETAINER, NITRONIC
7	202–9990–25	UPPER SEAL
8	60–1243–776	WEAR RING
9	60–1243–803	PISTON BODY, NITRONIC
10	202–9990–23	LOWER SEAL
11	60–1243–721	PISTON BASE, NITRONIC
12	69–1243–779	1000ml CYLINDER CAP SEAL
13	69–1243–780	1000ml CYLINDER, NITRONIC
14	69–1243–793	1000ml CYLINDER, HASTELLOY
15	60–1244–331	1000ml PISTON ASSY, HASTELLOY
16	60–1243–792	1000ml SEAL RETAINER, HASTELLOY
17	60–1243–794	PISTON BODY, HASTELLOY
19	209–0169–35	GLAND NUT, 1/16 ID
20	209–0169–34	FERRULE, 1/16 ID
21	209–0169–46	FERRULE, 1/8 ID
22	489–0100–01	CABLE TIE, TEFZEL
23	60–1243–774	RIGHT WASH TUBE
24	60–1243–773	LEFT WASH TUBE
25	60–1243–348	THRUST BEARING
26	60–1248–116	BALL NUT ASSY
27	60–1248–117	BALL SCREW ASSY
28	201–4299–02	THRUST BEARING (PAIR)
29	69–1244–415	UNIVERSAL SENSOR HARNESS
30	69–1243–431	WORM GEAR
31	60–1243–607	KEY
32	69–1243–563	EXTENDED WORM GEAR
33	201–0329–00	BEARING

NOTE: 1. This list is subject to change without notice.

REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–347
SHEET: 3 OF 3
REV.: G DATE: 073109

ITEM NO.	PART NUMBER	DESCRIPTION
34	411–0311–62	FUSE, 2 AMP "T"
35	411–0311–51	FUSE, 1 AMP "T"
36	120–0013–00	POWER FILTER, 6A
37	60–1244–236	LUBE WHEEL ASSY
38	60–1244–323	MAIN HARNESS
39	141–4001–02	SUB–D SOCKET
40	60–1243–492	SOAK PAD
41	60–1244–309	TRANSFORMER ASSY
42	410–7304–01	ROCKER SWITCH, DPDT, 4 AMP, CSA
43	60–1245–162	POWER DRIVE CBA, DIGITALLY ENCODED, 1000D
44	60–2254–132	MOTOR BRUSHES
45	113–3250–00	CAPACITOR, 5μf, 100VDC
46	60–1244–184	MOTOR ASSY FOR 1000D PUMP
47	60–1244–329	MOTOR ASSY FOR 1000DX PUMP
48	69–1243–800	COMBINATION GEAR FOR 1000D PUMP
49	69–1243–805	COMBINATION GEAR FOR 1000DX PUMP
50	150–0006–01	BRAKE
51	201–1337–00	BEARING CYLINDER
52	69–1243–560	GEAR
53	209–0169–44	GLAND NUT, 1/8 IB
54	60–1243–809	LOWER WEAR RING
55	60–1248–183	COOLING JACKET ASSY 1000D
56	209–0161–00	MALE HOSE CONNECTOR
57	202–2062–35	O–RING, 3.109 ID, .139 CROSS SECTION

NOTE: 1. This list is subject to change without notice.

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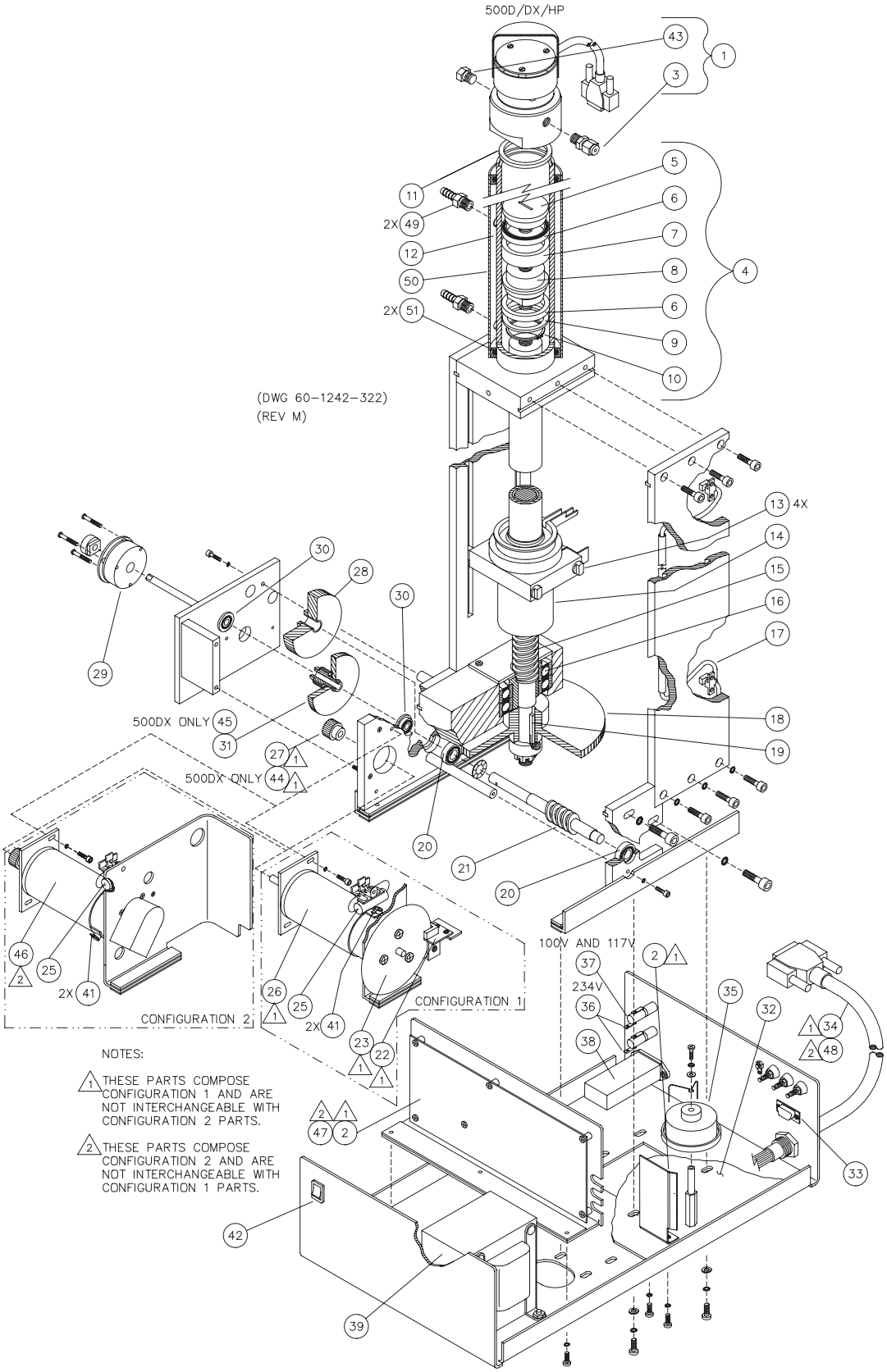
A.1.3 500D/DX Pump



REPLACEMENT PARTS LIST
Teledyne Isco, Inc.

DWG. NO.: 60-1242-322
SHEET: 2 OF 3
REV.: M DATE: 073109

ITEM NO.	PART NUMBER	DESCRIPTION
1	60-1244-239	PREAMP ASSY (NITRONIC)
1	60-1244-451	PREAMP ASSY (HASTELLOY)
3	209-0161-01	MALE CONNECTOR (STAINLESS STEEL)
3	209-0168-16	MALE CONNECTOR (HASTELLOY)
4	60-1244-221	500ML PISTON ASSY (NITRONIC)
4	60-1244-319	500ML PISTON ASSY (HASTELLOY)
5	60-1243-454	500ML SEAL RETAINER (NITRONIC)
5	69-1243-759	500ML SEAL RETAINER (HASTELLOY)
6	202-9091-56	SEAL
7	60-1243-538	WEAR RING
8	60-1243-535	PISTON BASE (NITRONIC)
8	69-1243-758	PISTON BASE (HASTELLOY)
9	60-1243-185	500ML WIPER RETAINER
10	209-0011-37	RETAINING RING
11	69-1243-455	500ML CYLINDER CAP SEAL
12	69-1243-577	500ML CYLINDER (NITRONIC)
12	69-1243-751	500ML CYLINDER (HASTELLOY)
13	60-1243-348	THRUST BEARING
14	60-1248-116	BALL NUT ASSY
15	60-1248-117	BALL SCREW ASSY
16	201-4299-02	THRUST BEARING (PAIR)
17	69-1244-415	UNIVERSAL SENSOR HARNESS
18	69-1243-431	WORM GEAR
19	60-1243-654	KEY
19	60-1243-607	SHEAR KEY (FOR 500HP ONLY)
20	201-0329-00	BEARING (SEE NOTE 3 AT BOTTOM OF PAGE)
21	69-1243-563	EXTENDED WORM GEAR
25	113-3250-00	CAP 5uF 100VDC
28	69-1243-560	SPUR GEAR
29	150-0006-01	BRAKE
30	201-1337-00	BEARING (SEE NOTE 3 AT BOTTOM OF PAGE)

Note: 1. For current prices and quotations on parts, contact Isco Customer Service Department.
2. This list is subject to change without notice.
3. Verify the part number with Isco Technical Service Department.

REPLACEMENT PARTS LIST
Teledyne Isco, Inc.

DWG. NO.: 60-1242-322
SHEET: 3 OF 3
REV.: M DATE: 073109

ITEM NO.	PART NUMBER	DESCRIPTION
	*CONFIGURATION 1	PARTS (NOT INTERCHANGEABLE WITH CONFIGURATION 2 PARTS)*
2	60-1244-260	POWER DRIVE CBA
22	69-1244-924	CBA TACH SENSOR
23	60-2255-029	TACH DISK
26	69-1243-562	MOTOR
27	69-1243-802	PINION GEAR
31	69-1243-800	COMBINATION GEAR
32	60-1243-492	SOAK PAD
33	141-4001-02	D-SUB SOCKET
34	60-1244-193	MAIN HARNESS
35	60-1244-236	LUBE WHEEL ASSY
36	411-0311-51	FUSE 1 AMP "T"
37	411-0311-62	FUSE 2 AMP "T"
38	120-0013-00	POWER FILTER 6A
39	60-1244-309	TRANSFORMER ASSY
40	60-1244-220	GEAR LUBRICATION ASSY (NOT SHOWN)
41	60-2254-132	MOTOR BRUSHES
42	410-7304-01	SW DPDT ROCKER CSA 4A
43	209-0168-05	PIPE PLUG (STAINLESS STEEL)
43	209-0165-78	PIPE PLUG (HASTELLOY)
44	69-1243-717	24T, 24P PINION GEAR
45	69-1243-718	COMBINATION GEAR
49	209-0161-00	MALE HOSE CONNECTOR
50	60-1248-099	COOLING JACKET ASSY 500ML
51	202-2062-11	O-RING, 2.109 ID, .139 CROSS SECTION
	*CONFIGURATION 2	PARTS (NOT INTERCHANGEABLE WITH CONFIGURATION 1 PARTS)*
46	60-1244-444	MOTOR MOUNT ASSEMBLY
47	60-1245-161	CBA SYRINGE PUMP DRIVE UNITS, 500D
47	60-1245-176	CBA MOTOR DRIVE (FOR 500HP ONLY)
48	60-1244-323	MAIN HARNESS

Note: 1. For current prices and quotations on parts, contact Isco Customer Service Department.
2. This list is subject to change without notice.
3. Verify the part number with Isco Technical Service Department.

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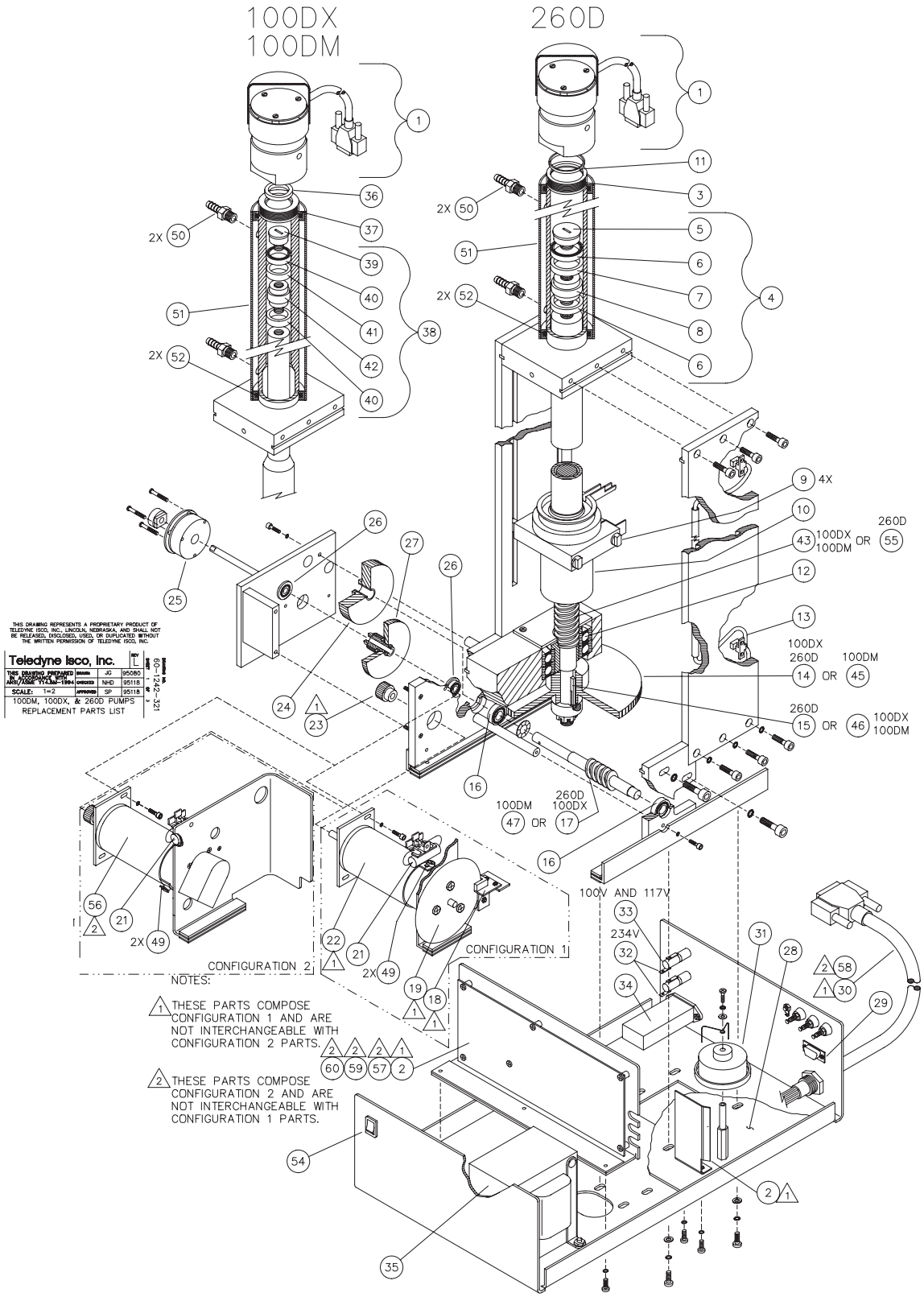
A.1.4 100DM/DX and 260D Pumps



REPLACEMENT PARTS LIST
Teledyne Isco, Inc.

DWG. NO.: 60-1242-321
SHEET: 2 OF 3
REV.: L DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
1	60-1244-235	PREAMPLIFIER CBA ASSY
3	69-1243-576	260ML NITRONIC CYLINDER
4	60-1244-216	PISTON ASSY
5	60-1243-414	SEAL RETAINER
6	202-9091-06	SEAL
7	60-1243-537	WEAR RING
8	60-1243-534	PISTON BASE
9	60-1243-348	THRUST BEARING
10	60-1248-116	BALL NUT ASSY
11	69-1243-444	CYLINDER SEAL
12	201-4299-02	THRUST BEARING (PAIR)
13	69-1244-415	UNIVERSAL SENSOR HARNESS
14	69-1243-431	WORMGEAR (260D, 100DX)
15	60-1243-607	KEY
16	201-0329-00	BEARING (SEE NOTE 3)
17	69-1243-563	EXTENDED WORM GEAR (260D, 100DX)
21	113-3250-00	CAP 5uF 100VDC
24	69-1243-560	GEAR SPUR
25	150-0006-01	BRAKE
26	201-1337-00	BEARING (SEE NOTE 3)
27	69-1243-800	COMBINATION GEAR
28	60-1243-492	SOAK PAD
29	141-4001-02	D-SUB SOCKET
31	60-1244-236	LUBE WHEEL ASSY
	*CONFIGURATION 1	PARTS (NOT INTERCHANGEABLE WITH CONFIGURATION 2 PARTS)*
2	60-1244-260	POWER DRIVE CBA
18	69-1244-924	CBA TACH SENSOR
19	60-2255-029	TACH DISK
22	69-1243-562	MOTOR
23	69-1243-802	GEAR PIN
30	60-1244-193	MAIN HARNESS

Note: 1. For current prices and quotations on parts, contact Isco Customer Service Department.
2. This list is subject to change without notice.
3. Verify the part number with Isco Technical Service Department.

REPLACEMENT PARTS LIST
Teledyne Isco, Inc.

DWG. NO.: 60-1242-321
SHEET: 3 OF 3
REV.: L DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
32	411-0311-51	FUSE 1 AMP "T"
33	411-0311-62	FUSE 2 AMP "T"
34	120-0013-00	POWER FILTER 6A
35	60-1244-309	TRANSFORMER ASSY
36	69-1243-465	CYLINDER CAP SEAL
37	69-1243-575	100ML CYLINDER
38	60-1244-223	PISTON ASSY
39	60-1243-468	PISTON SEAL RETAINER
40	202-9090-75	SEAL
41	60-1243-536	WEAR RING
42	60-1243-533	PISTON BASE
43	60-1248-127	BALL SCREW ASSY (100DM, 100DX)
44		
45	69-1243-485	WORM GEAR (100DM)
46	60-1243-608	KEY (100DM, 100DX)
47	69-1243-605	EXTENDED WORM GEAR (100DM)
48	60-1244-220	GEAR LUBRICATION ASSY (NOT SHOWN)
49	60-2254-132	MOTOR BRUSHES
50	209-0161-00	MALE HOSE CONNECTOR
51	60-1248-053	COOLING JACKET ASSY
52	202-2062-23	O-RING, 1.609 ID, .139 CROSS SECTION
54	410-7304-01	SW DPDT ROCKER CSA 4A
55	60-1248-117	BALL SCREW ASSY (260D)
	*CONFIGURATION 2	PARTS (NOT INTERCHANGEABLE WITH CONFIGURATION 1 PARTS)*
56	60-1244-444	MOTOR MOUNT ASSEMBLY
57	60-1245-158	CBA FOR SYRINGE PUMP DRIVE UNITS, 100DM
58	60-1244-323	MAIN HARNESS
59	60-1245-159	CBA FOR SYRINGE PUMP DRIVE UNITS, 100DX
60	60-1245-160	CBA FOR SYRINGE PUMP DRIVE UNITS, 260D

Note: 1. For current prices and quotations on parts, contact Isco Customer Service Department.
2. This list is subject to change without notice.
3. Verify the part number with Isco Technical Service Department.

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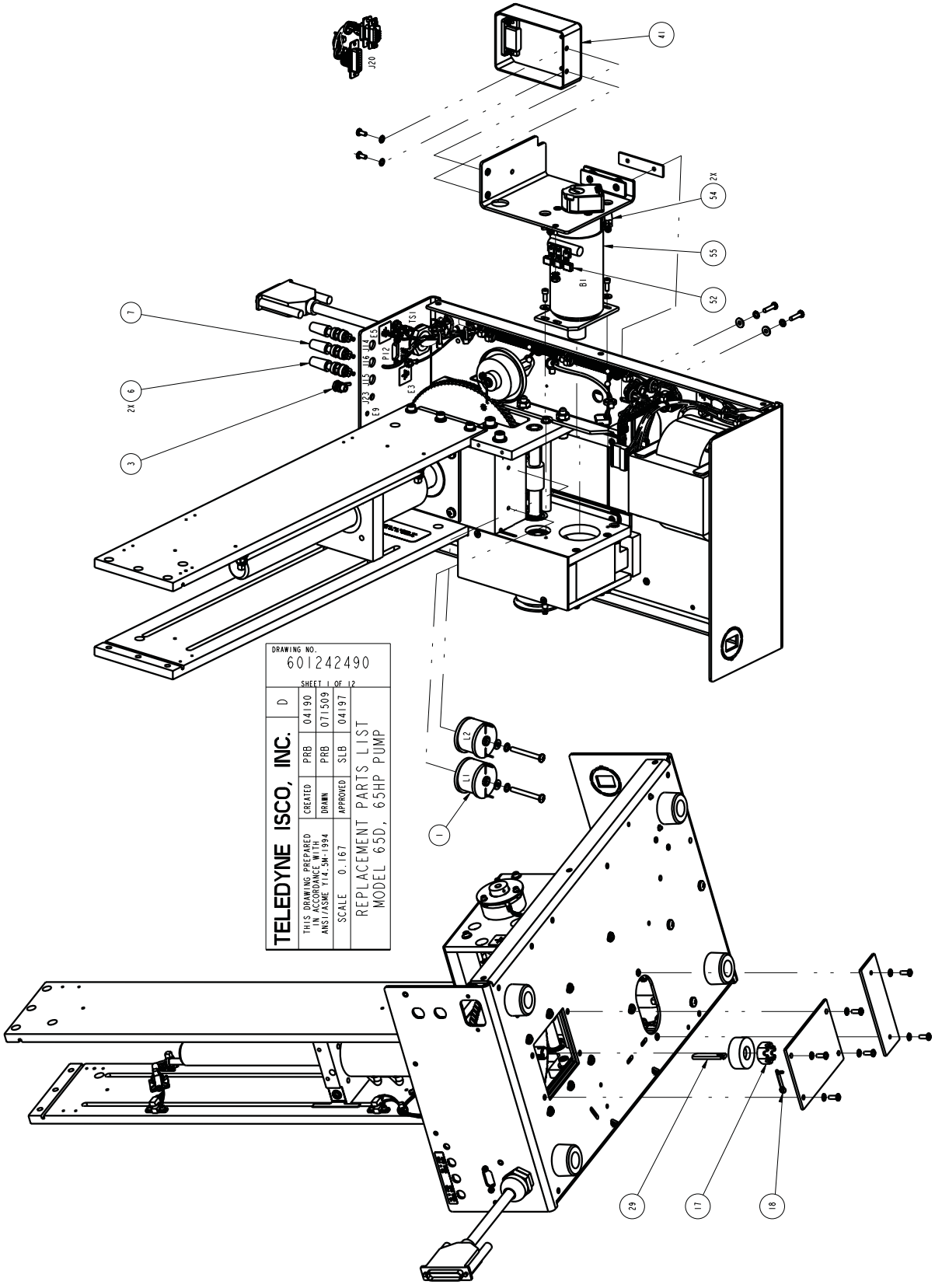
A.1.5 65D Pump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601242490
SHEET 1 OF 12
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SCALE 0.167
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MODEL 65D, 65HP PUMP
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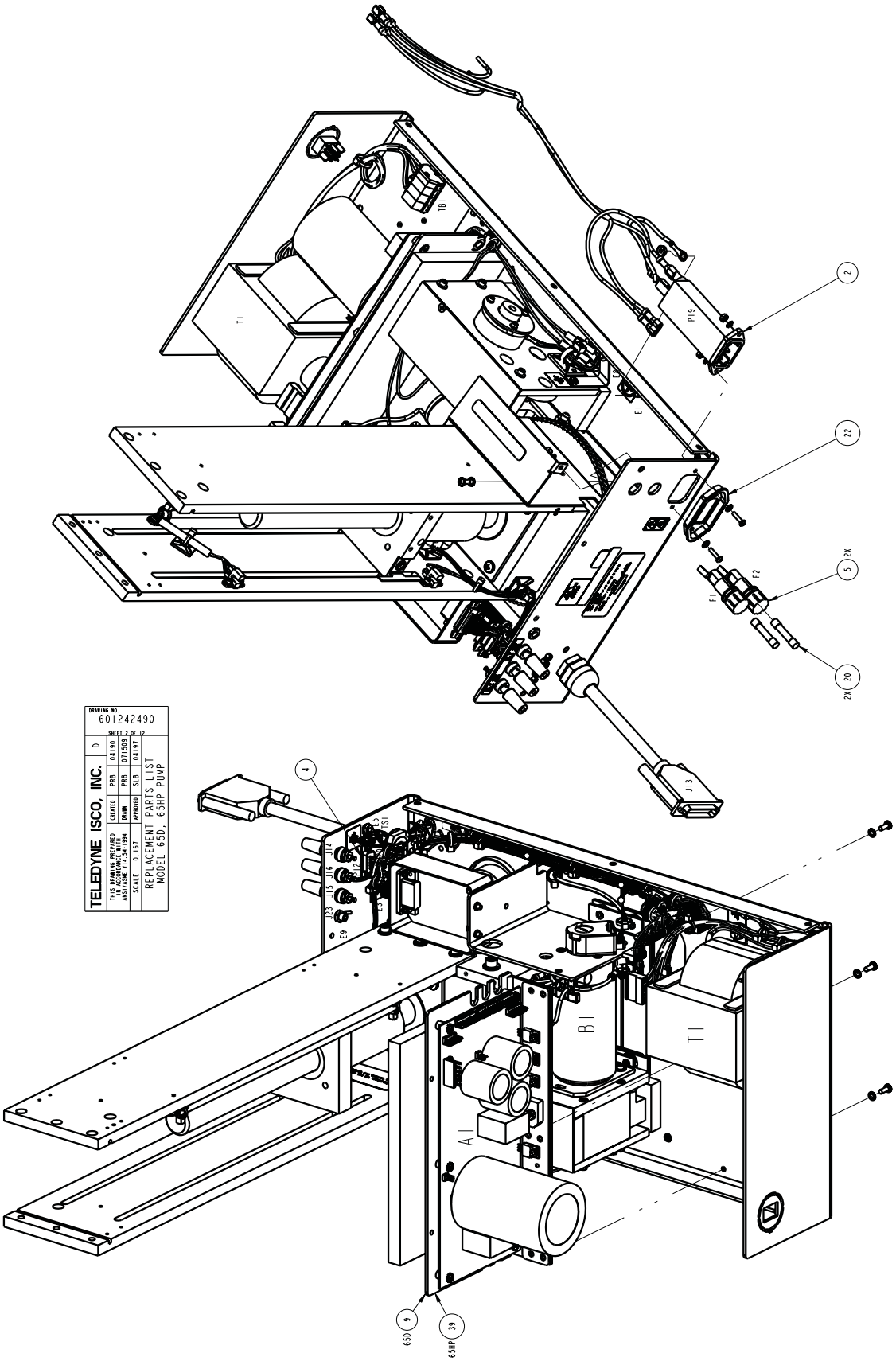
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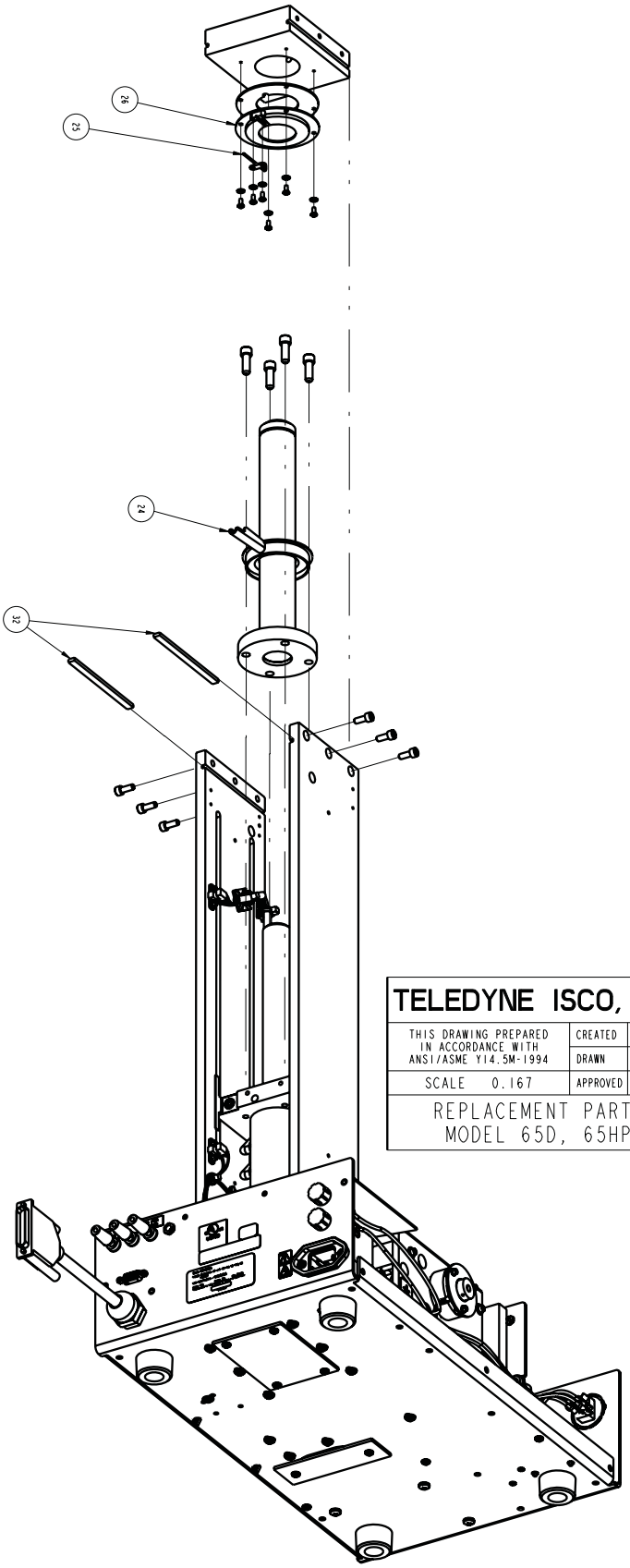
65HP



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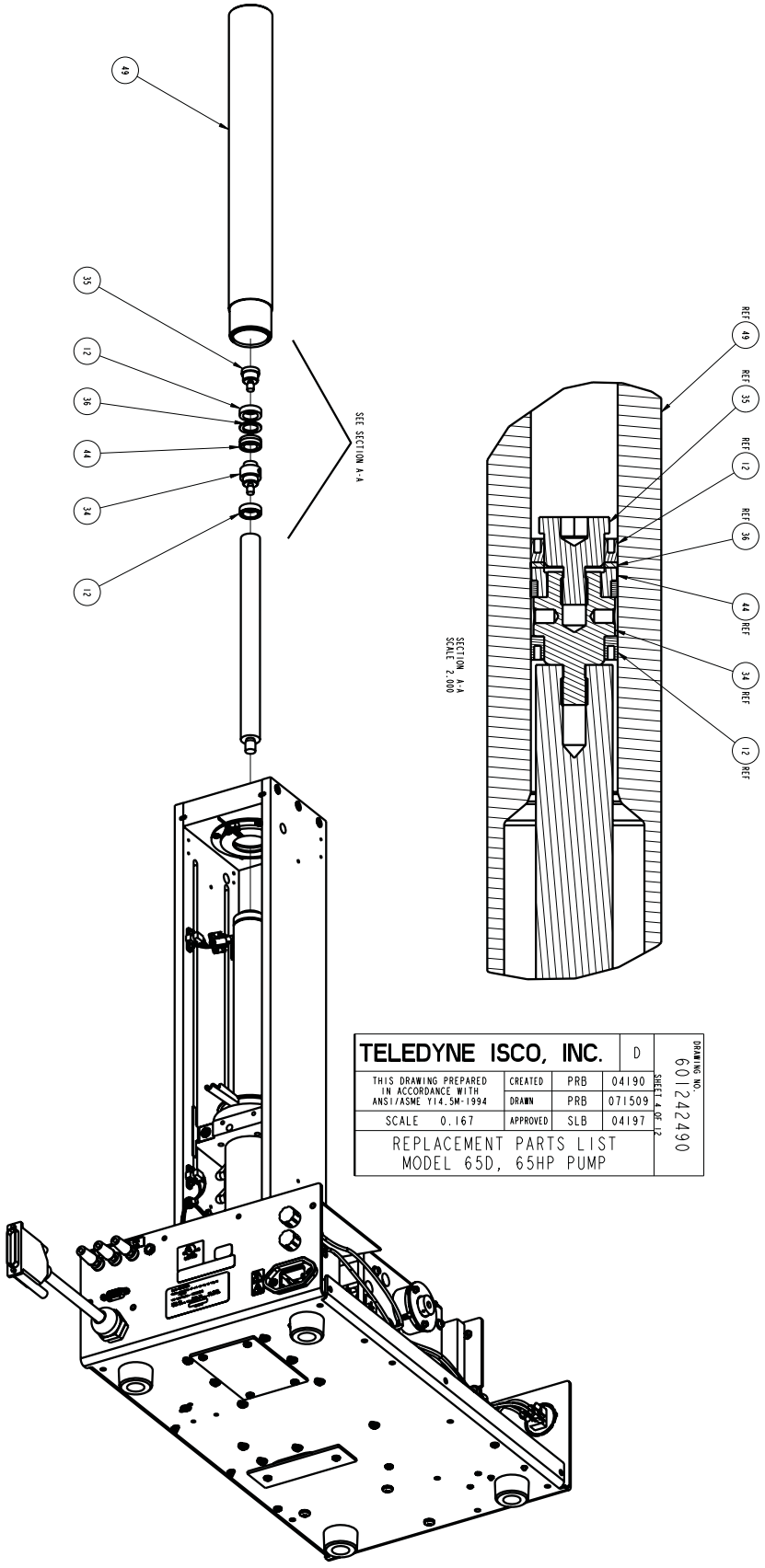
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DRAWN PRB 071509
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MODEL 65D, 65HP PUMP
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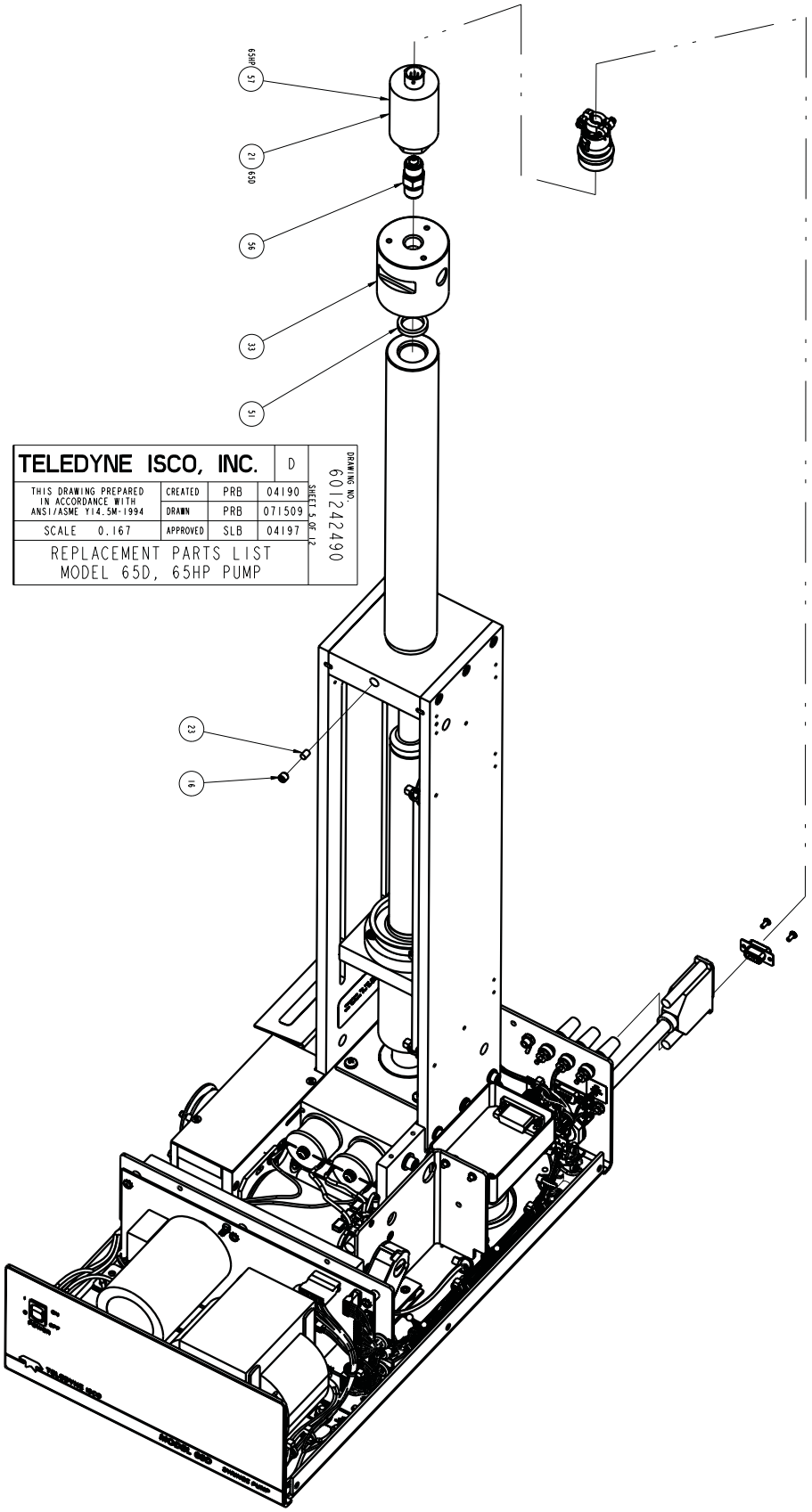
SHEET 4 OF 12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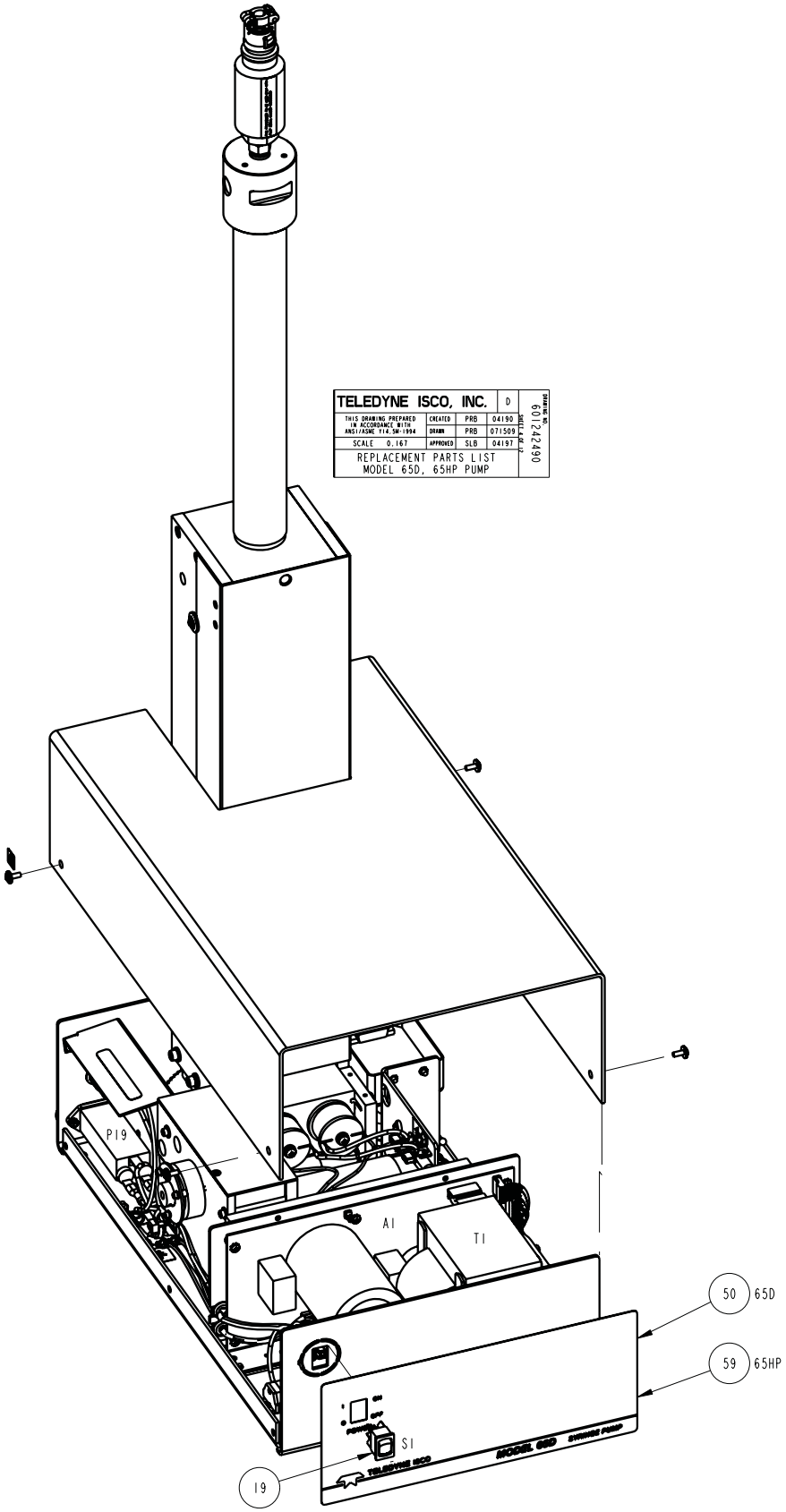
REPLACEMENT PARTS LIST
MODEL 65D, 65HP PUMP
DRAWING NO. 60142490
SHEET 5 OF 12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APPROVED SLB 04197
SCALE 0.167
REPLACEMENT PARTS LIST
MODEL 65D, 65HP PUMP
DRAWING NO. 60124290
SHEET 1 OF 2
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65D
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65HP
S1
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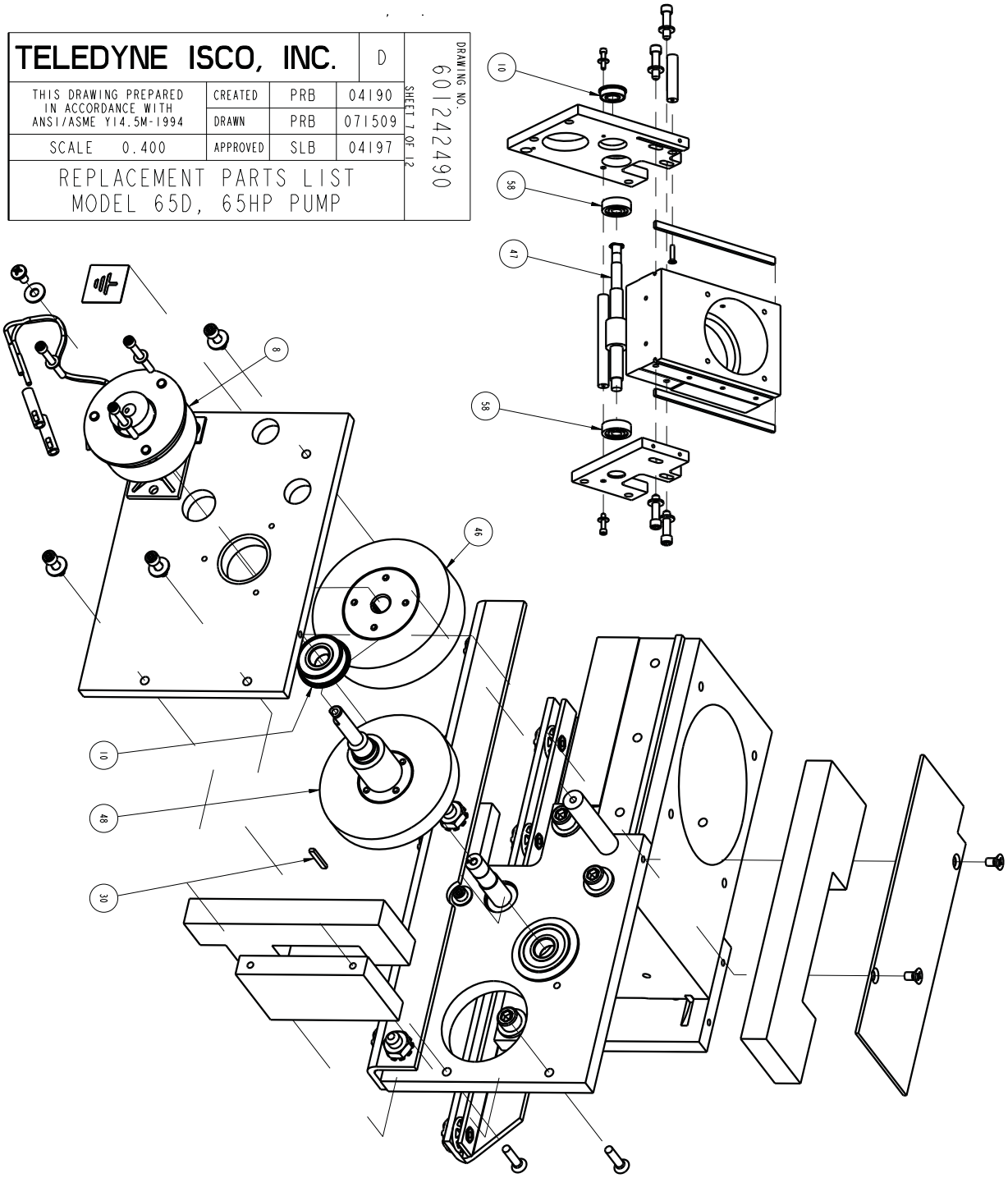
MODEL 65D SYRINGE PUMP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SCALE 0.400
APPROVED SLB 04197
SHEET 1 OF 12
REPLACEMENT PARTS LIST
MODEL 65D, 65HP PUMP
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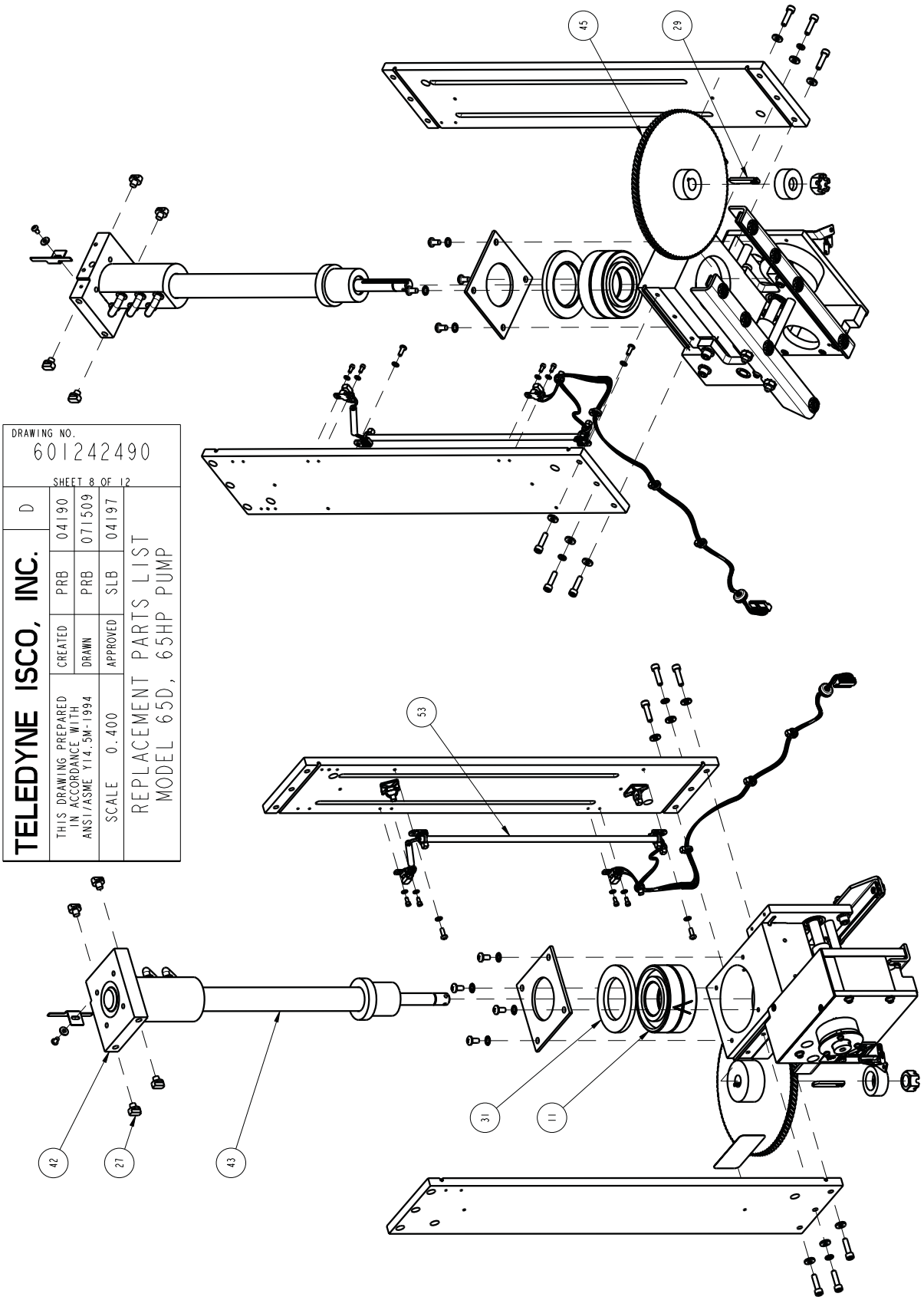
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SHEET 8 OF 12
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MODEL 65D, 65HP PUMP
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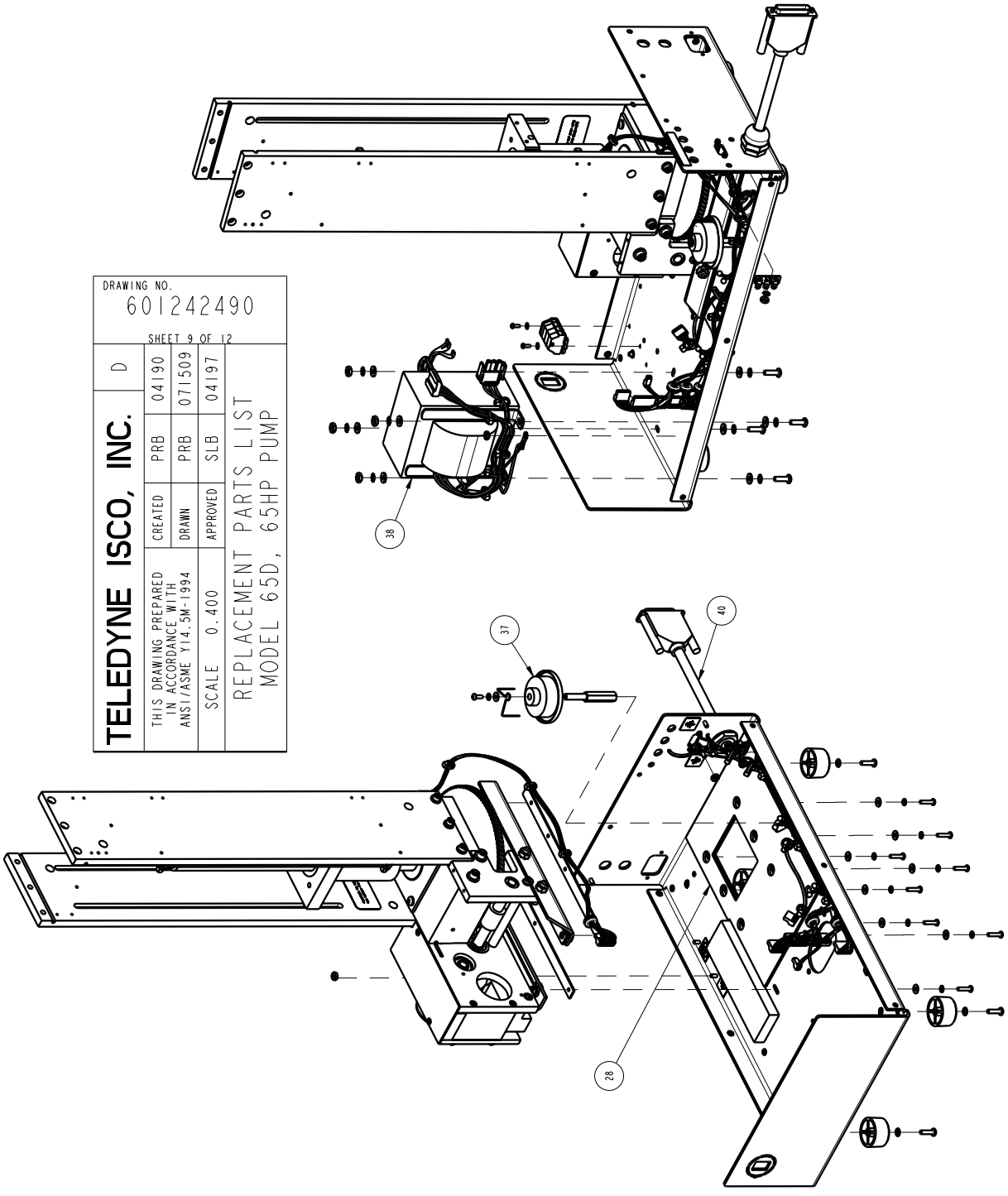
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601242490
SHEET 9 OF 12
D
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CREATED PRB 04190
DRAWN PRB 071509
APPROVED SLB 04197
SCALE 0.400
REPLACEMENT PARTS LIST
MODEL 65D, 65HP PUMP
38
37
40
28

601242490

REPLACEMENT PARTS LIST

SHEET: 10 OF 12

TELEDYNE ISCO, INC.

REV: D | DATE: 071509

ITEM NO.	PART NUMBER	DESCRIPTION
1	120-0007-01	CHOKE, 330 UH, 11.0 AMP
2	120-0013-00	POWER FILTER, 6 AMP
3	141-3500-20	PANEL MOUNT BANANA JACK
4	141-4001-02	D-SUB SOCKET
5	142-1104-00	FUSE HOLDER
6	143-4007-00	BINDING POST RED
7	143-4008-00	BINDING POST BLACK
8	150-0006-01	BRAKE, FLSF RVS 24V
9	60-1245-157	POWER DRIVE CBA MOD (FOR 65D ONLY)
10	201-1337-00	BEARING (VERIFY PART# WITH ISCO SERVICE DEPT.)
11	201-4299-02	THRUST BALL BEARING, 35MM ID X 72MM OD
12	202-9096-08	SEAL, .563 ID X .813 OD
16	231-2007-04	SET SCREW, 1/4-20 X 1/4, STL, CUP POINT
17	232-6097-00	SLOTTED HEX NUT, 1/2-20, STL
18	236-0008-12	COTTOR PIN, .125 X .75 LONG, SST OR STL
19	410-7304-01	ROCKER SWITCH, DPDT, 4 AMP, CSA
20	411-0311-62	FUSE, 2.0 AMP (FOR 100/117V UNITS)
21	460-0101-11	TRANSDUCER, 0-20K PSI, SST (FOR 65D ONLY)
22	60-0823-201	DRIP SHIELD
23	60-1153-073	DELRIN PLUG
24	60-1243-201	DRIP PAN
25	60-1243-202	NITROGEN PURGE TUBE
26	60-1243-234	NITROGEN PURGE PAN
27	60-1243-348	SLIDE THRUST BEARING

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

601242490

REPLACEMENT PARTS LIST

SHEET: 11 OF 12

TELEDYNE ISCO, INC.

REV: D | DATE: 071509

ITEM NO.	PART NUMBER	DESCRIPTION
28	60-1243-492	SOAK PAD, GEAR TRAIN BASE
29	60-1243-607	SHEAR KEY
30	60-1243-610	KEY, GEAR TRAIN
31	60-1243-624	BEARING RETAINING RING
32	60-1243-682	KEY
33	60-1243-876	CYLINDER CAP, 65ML
34	60-1243-882	PISTON BASE, 65ML
35	60-1243-883	SEAL RETAINER, 65ML
36	60-1343-901	BACK UP RING, PRIMARY SEAL
37	60-1244-236	LUBE WHEEL ASSY
38	60-1244-309	TRANSFORMER ASSY, IEC 1010-1
39	60-1245-170	MOTOR DRIVE CBA MOD (FOR 65HP ONLY)
40	60-1244-323	MAIN HARNESS FOR PUMP
41	60-1244-414	TRANSDUCER ASSY
42	60-1248-116	BALL NUT ASSY
43	60-1248-127	BALL SCREW ASSY
44	60-1248-182	WEAR RING, 65ML
45	69-1243-431	WORM GEAR
46	69-1243-560	SPUR GEAR
47	69-1243-563	EXTENDED WORM
48	69-1243-800	COMBINATION GEAR
49	69-1243-874	CYLINDER, SYRINGE PUMP, 65ML
50	69-1243-875	FRONT PANEL LABEL (FOR 65D ONLY)
51	69-1243-880	CYLINDER CAP SEAL
52	69-1244-411	TERMINAL STRIP ASSY

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

601242490

REPLACEMENT PARTS LIST

SHEET: 12 OF 12

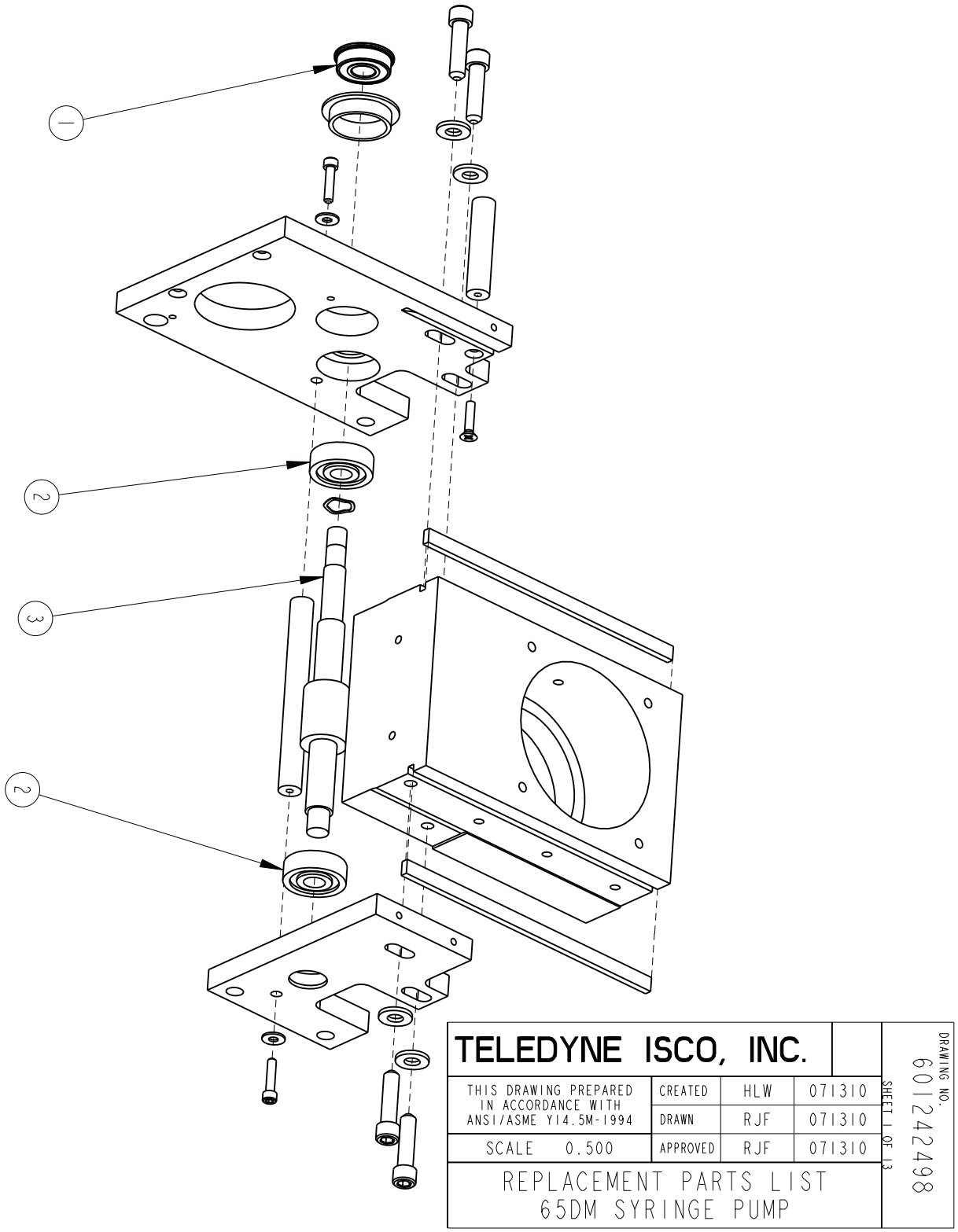
TELEDYNE ISCO, INC.

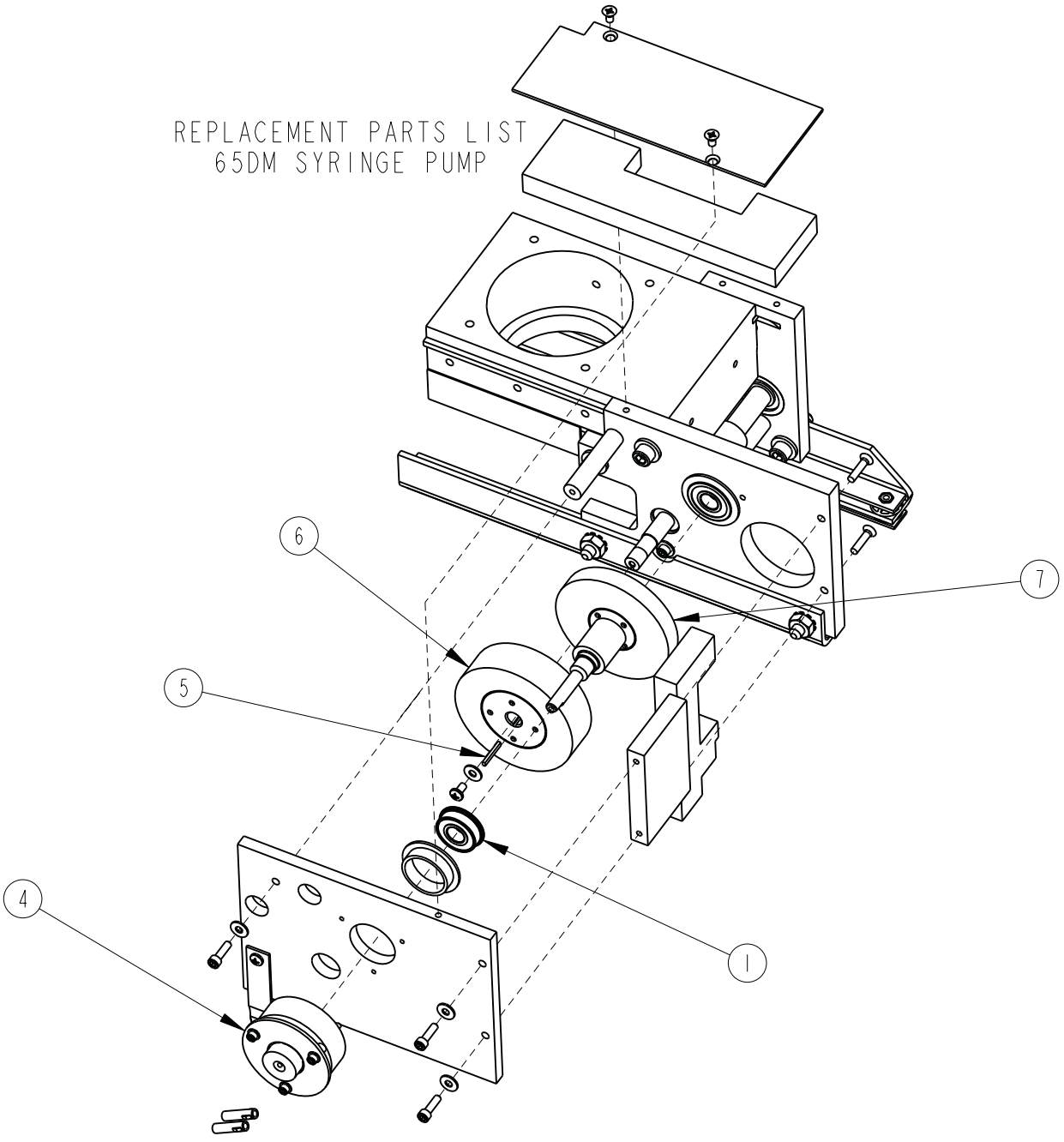
REV: D | DATE: 071509

ITEM NO.	PART NUMBER	DESCRIPTION
53	69-1244-415	HARNESS, UNIVERSAL SENSOR
54	60-2254-132	MOTOR BRUSHES (PKG OF 2)
55	60-1244-184	MOTOR ASSY
56	60-5363-068	ADAPTER, F250C MALE TO F250C MALE
57	460-0101-19	TRANSDUCER, 0-30K PSI, SST (FOR 65HP ONLY)
58	201-0329-00	BEARING CYLINDER
59	69-1243-958	FRONT PANEL LABEL (FOR 65HP ONLY)

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

A.1.6 65DM


1
2
3
2
TELEDYNE ISCO, INC.
THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI/ASME Y14.5M-1994
CREATED HLW 071310
DRAWN RJF 071310
SCALE 0.500
APPROVED RJF 071310
REPLACEMENT PARTS LIST
65DM SYRINGE PUMP
DRAWING NO. 60124248
SHEET 1 OF 13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65DM SYRINGE PUMP
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7
5
4
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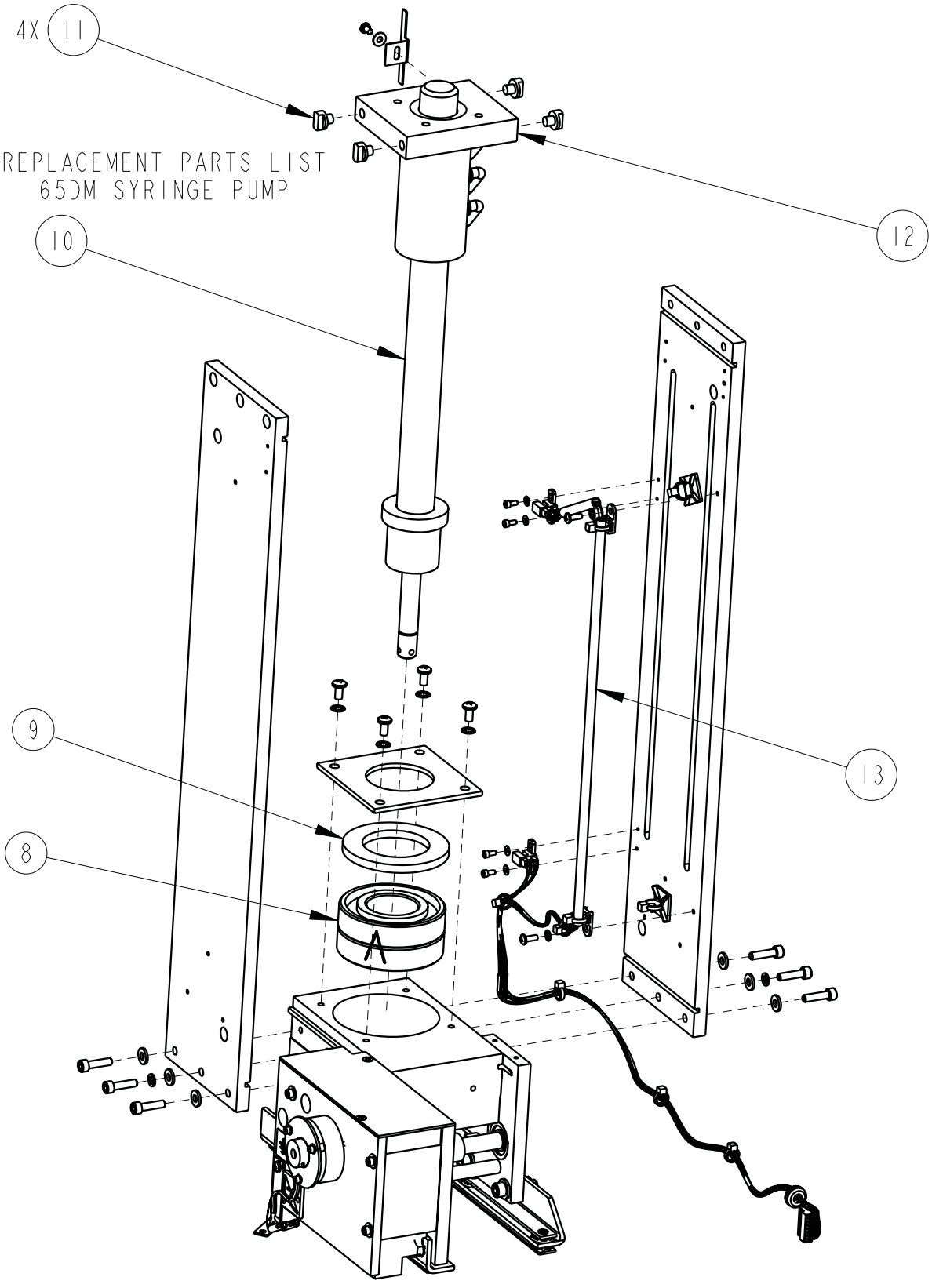
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65DM SYRINGE PUMP
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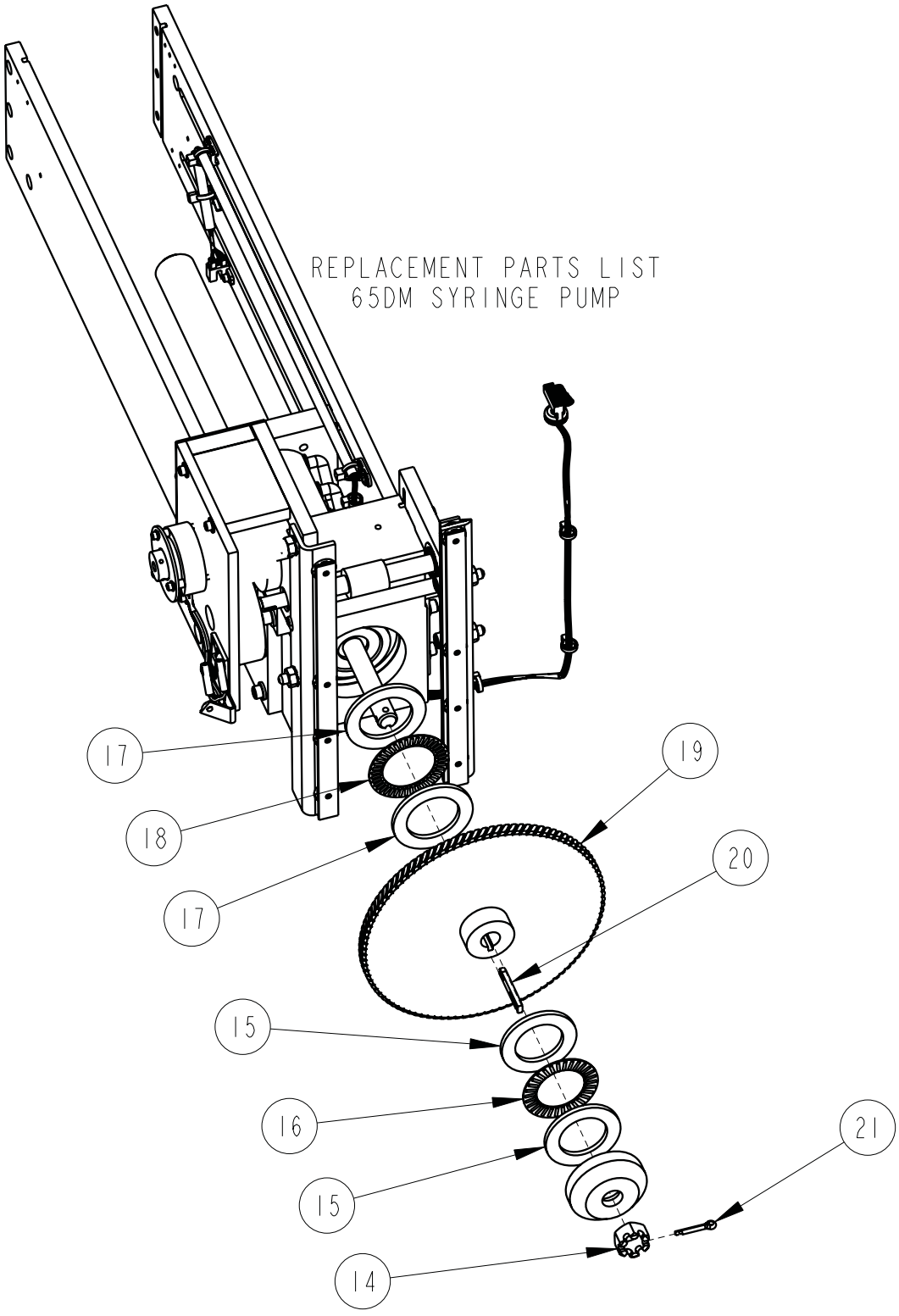
12
9
13
8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18
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14
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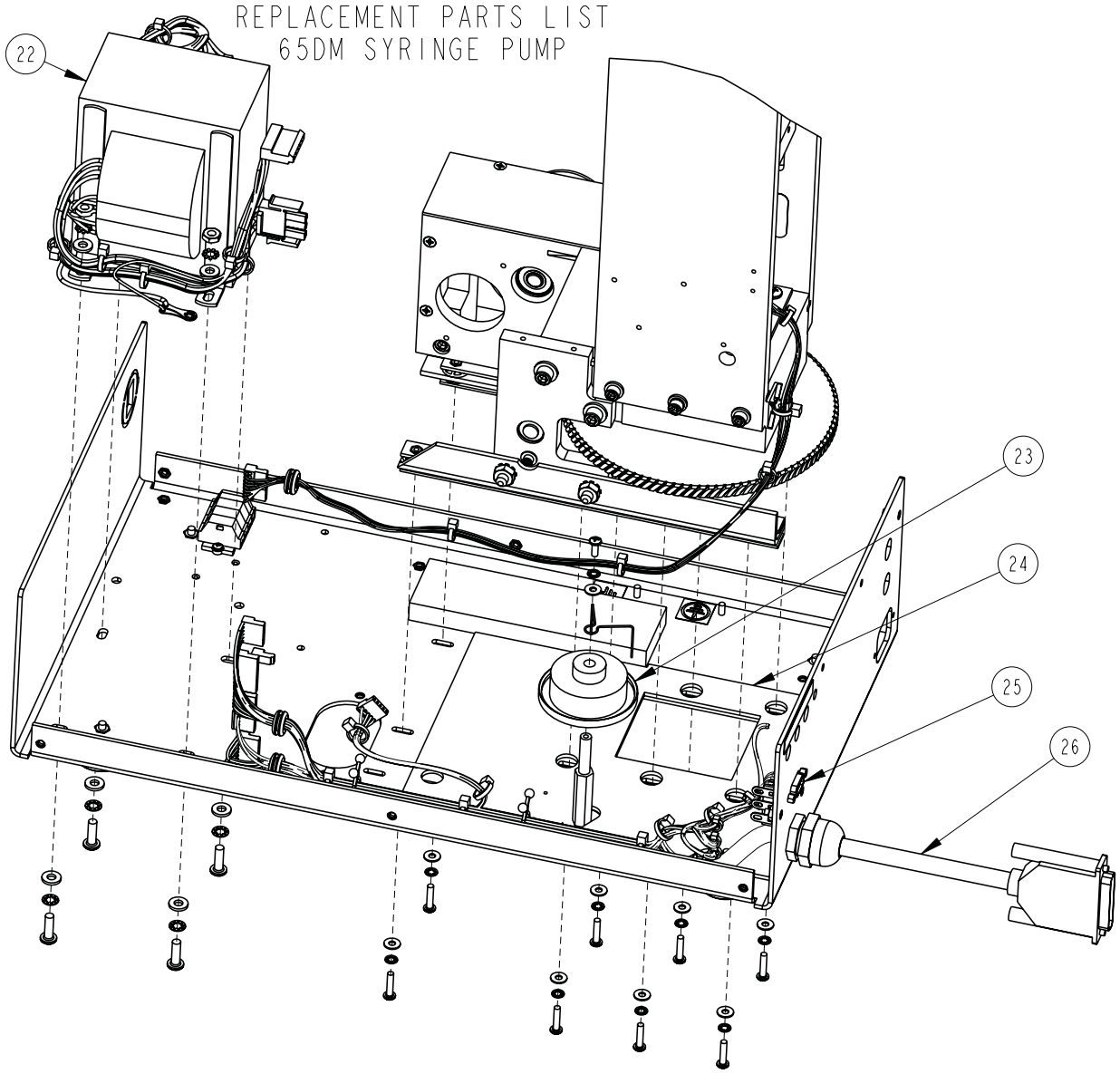
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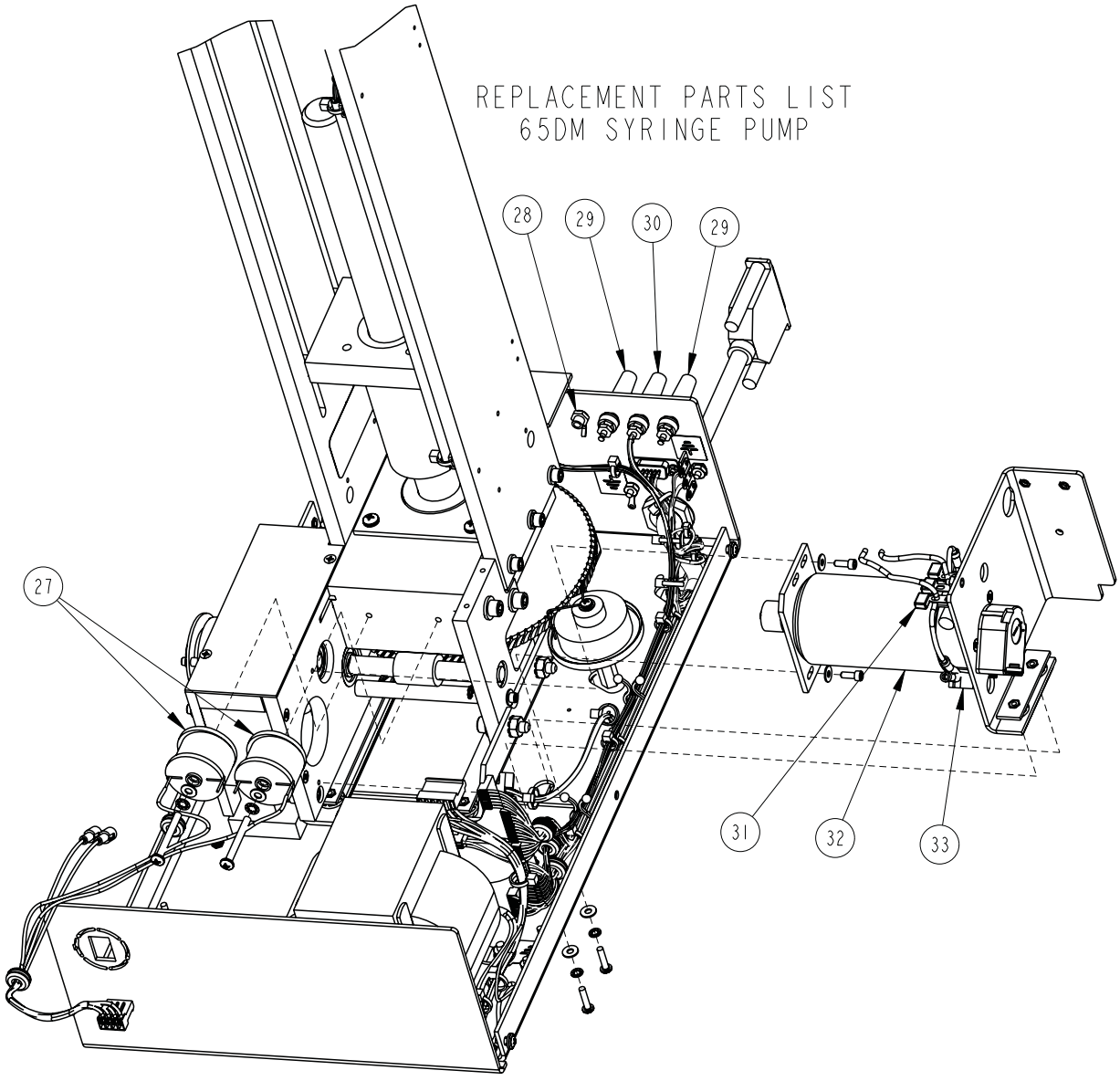
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65DM SYRINGE PUMP
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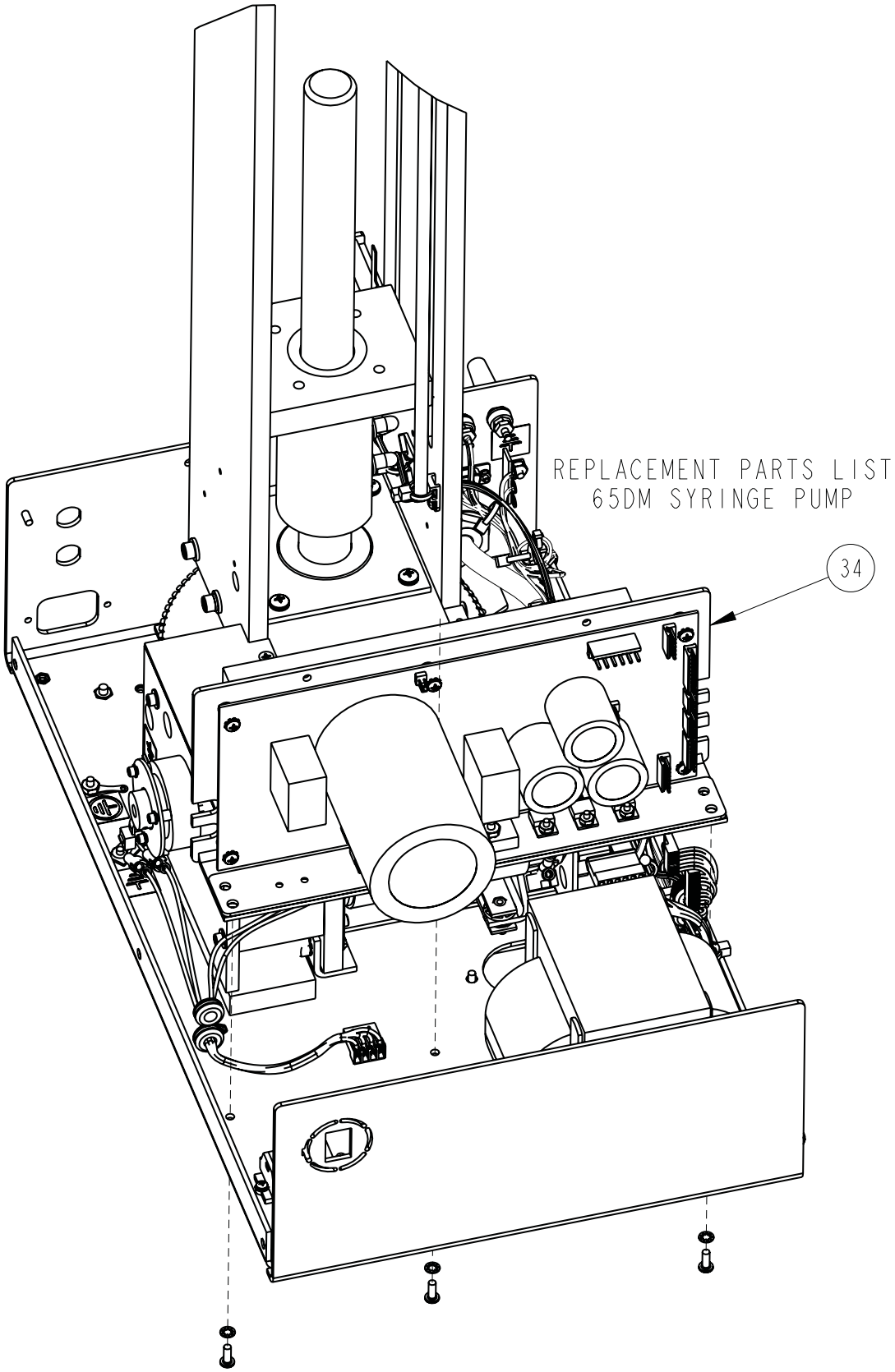
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65DM SYRINGE PUMP
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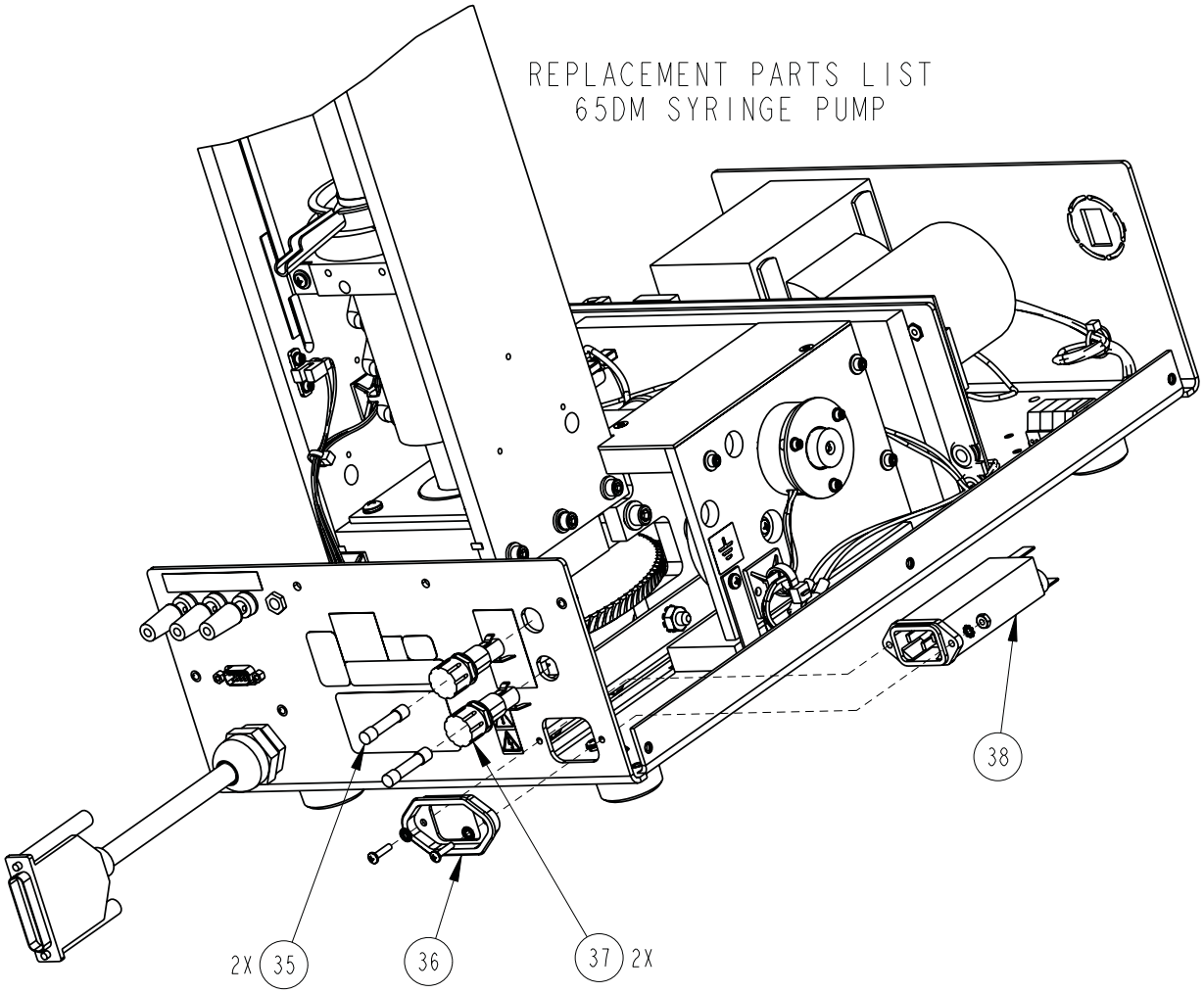
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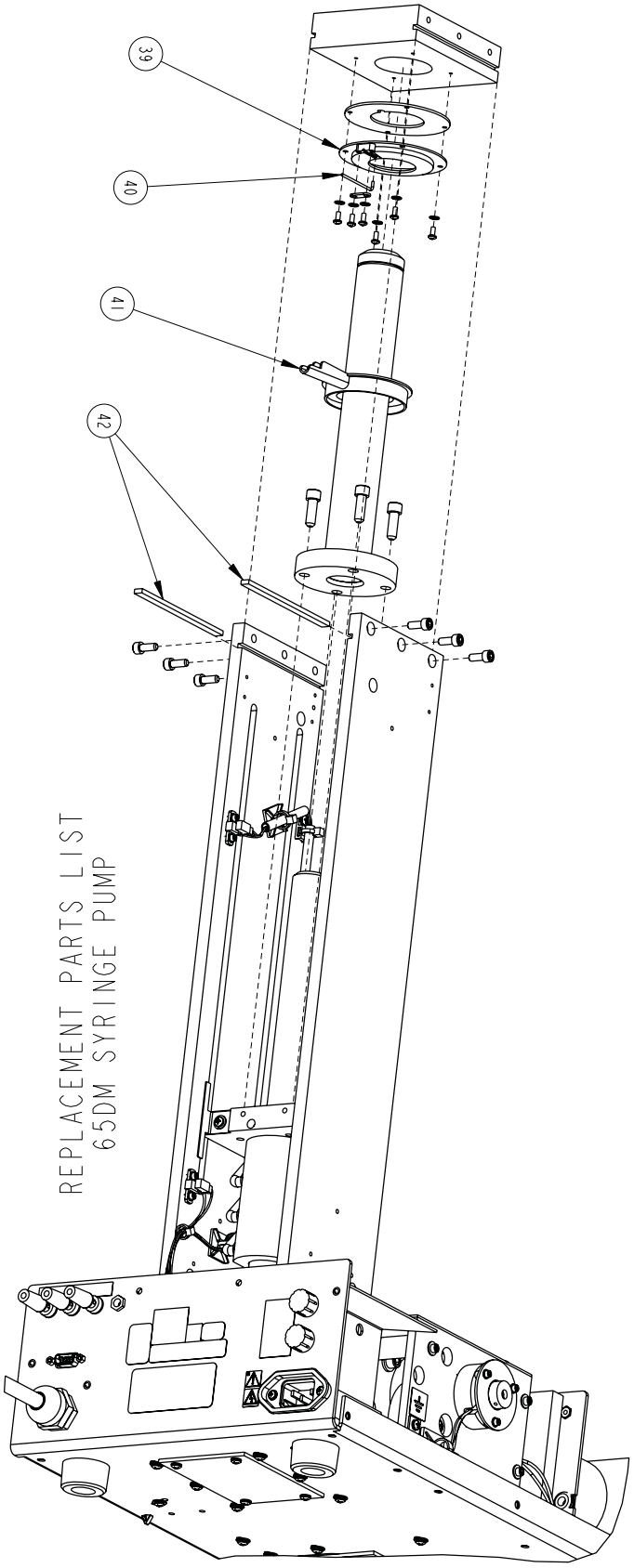
37 2X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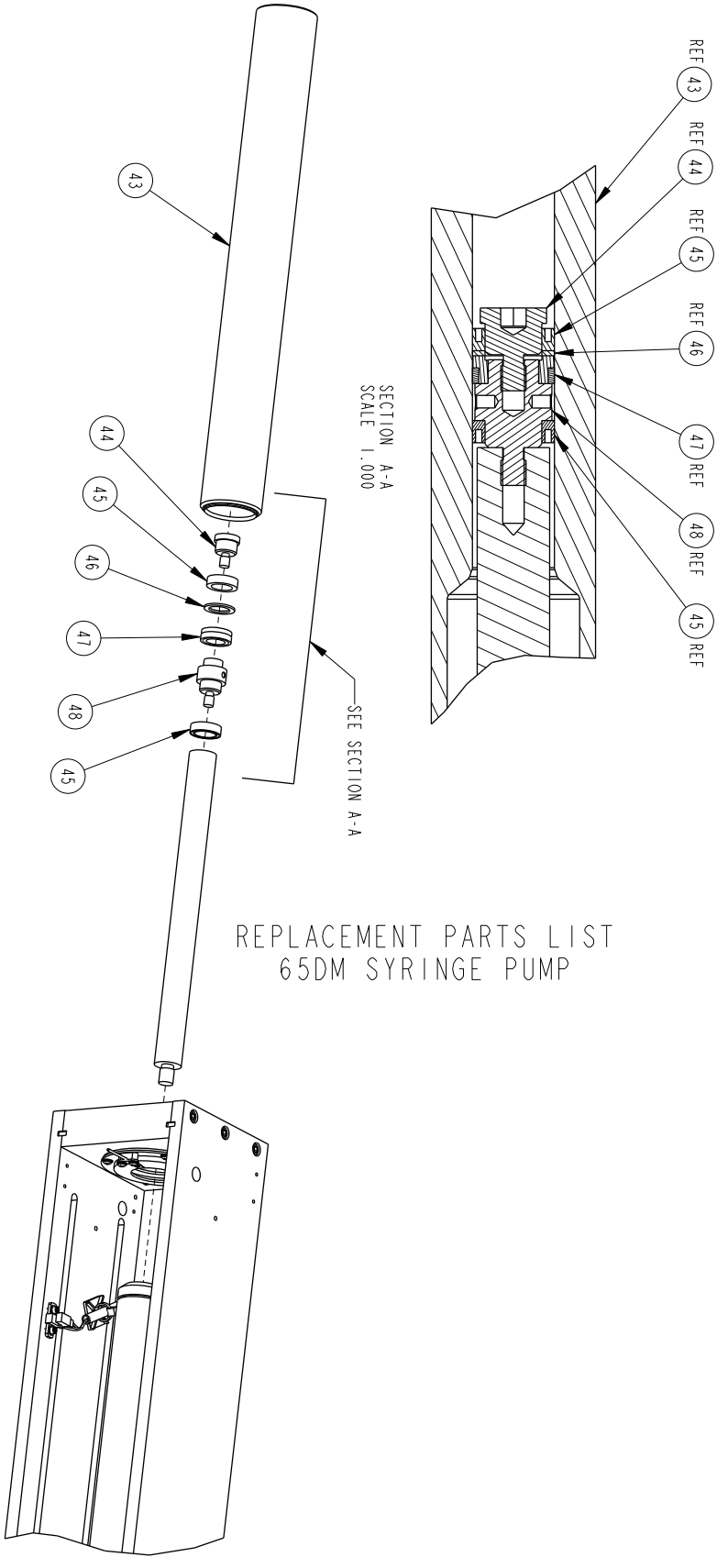
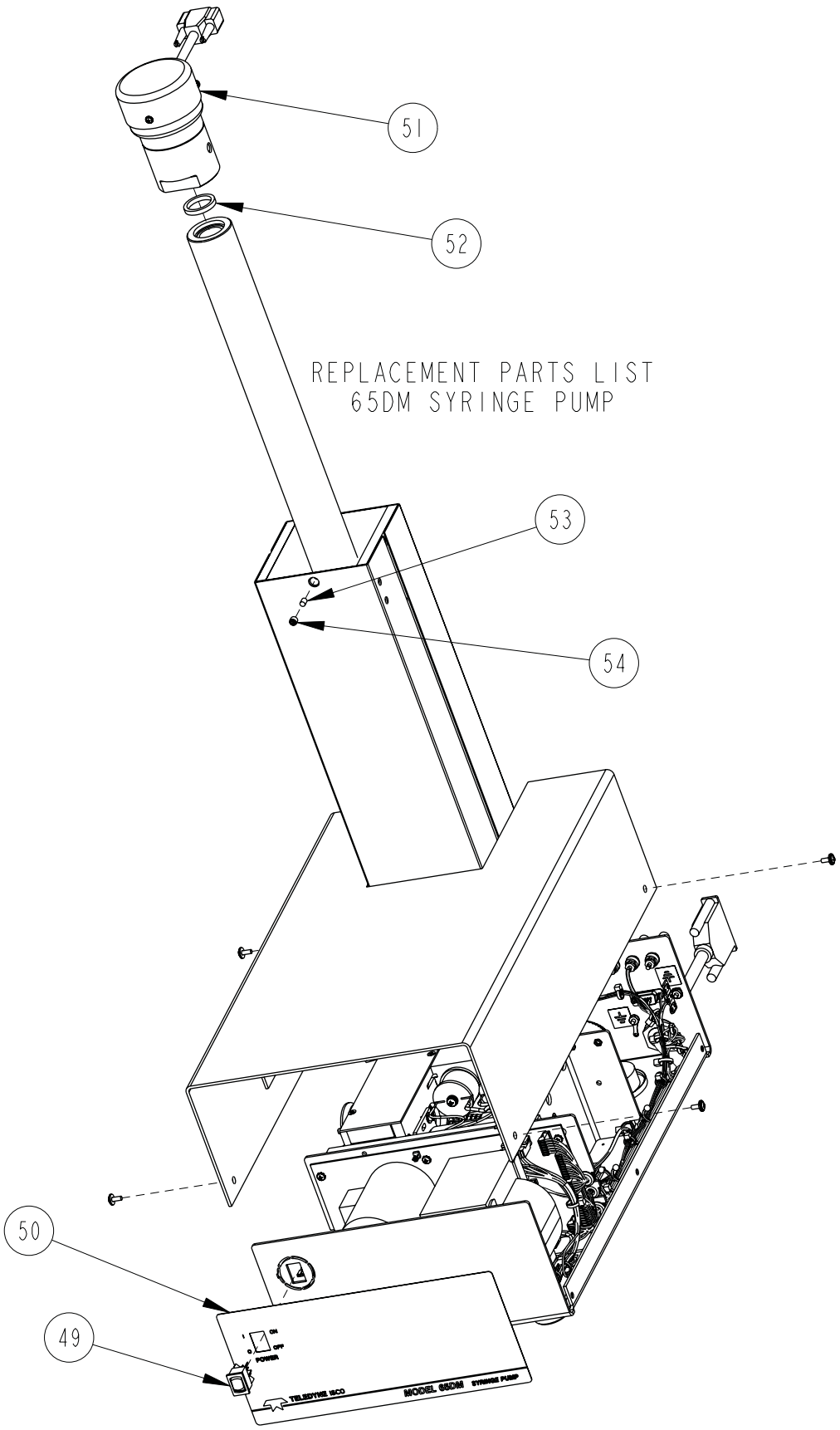
REPLACEMENT PARTS LIST
65DM SYRINGE PUMP



REPLACEMENT PARTS LIST
65DM SYRINGE PUMP


51
52
REPLACEMENT PARTS LIST
65DM SYRINGE PUMP
53
54
50
49
ON
OFF
POWER
TELEDYNE ISCO
MODEL 65DM SYRINGE PUMP

601242498

REPLACEMENT PARTS LIST

SHEET: 11 OF 13

REV:

TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
1	201-1337-00	BEARING (VERIFY PART# WITH ISCO SERVICE DEPT)
2	201-0329-00	BEARING CYLINDER
3	69-1243-563	EXTENDED WORM GEAR
4	150-0006-01	BRAKE, FAILSAFE REVERSE, 24V, .25 BORE
5	60-1243-610	GEAR TRAIN KEY
6	69-1243-560	SPUR GEAR
7	69-1243-800	COMBINATION GEAR
8	201-4299-02	THRUST BALL BEARING, 35MM ID X 72MM OD
9	60-1243-624	BEARING RETAINING RING
10	60-1248-127	BALL SCREW ASSY
11	60-1243-348	SLIDE THRUST BEARING
12	60-1248-116	BALL NUT ASSY
13	69-1244-415	HARNESS, UNIVERSAL SENSOR
14	232-6097-00	SLOTTED HEX NUT, 1/2-20, STEEL
15	201-6299-52	THRUST WASHER, 1-1/4
16	201-6299-02	THRUST BEARING, 1-1/4
17	201-6299-51	THRUST WASHER, 1-3/8
18	201-6299-01	THRUST BEARING, 1-3/8
19	60-1245-168	WORM GEAR MOD
20	60-1243-949	SHEAR KEY
21	236-0008-12	COTTER PIN, .125 X .75 LONG, SST OR STL
22	60-1244-309	TRANSFORMER ASSY
23	60-1244-236	LUBE WHEEL ASSY
24	60-1243-492	SOAK PAD
25	141-4001-02	D-SUB SOCKET

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

601242498

REPLACEMENT PARTS LIST

SHEET: 12 OF 13

REV:

TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
26	60-1244-323	MAIN HARNESS
27	120-0007-01	CHOKE, 330UH, 11 AMP
28	141-3500-20	PANEL MOUNT BANANA JACK
29	143-4007-00	BINDING POST, RED
30	143-4008-00	BINDING POST, BLACK
31	69-1244-411	TERMINAL STRIP ASSY
32	60-1244-184	MOTOR ASSY
33	60-2254-132	MOTOR BRUSHES (PKG OF 2)
34	60-1245-169	MOTOR DRIVE CBA MOD, 65DM
35	411-0311-62	FUSE, 2 AMP (FOR 100/117V UNITS)
36	60-0823-201	DRIP SHIELD
37	142-1104-00	FUSE HOLDER
38	120-0013-00	POWER FILTER, 6 AMP
39	60-1243-234	NITROGEN PURGE PAN
40	60-1243-202	NITROGEN PURGE TUBE
41	60-1243-201	DRIP PAN
42	60-1243-682	KEY
43	69-1243-947	CYLINDER, 65DM SYRINGE PUMP
44	60-1243-883	SEAL RETAINER, 65ML
45	202-9096-08	SEAL, .563 ID X .813 OD
46	60-1243-901	BACK UP RING, 65D PRIMARY SEAL
47	60-1248-182	WEAR RING, 65ML
48	60-1243-882	PISTON BASE, 65ML
49	410-7304-01	ROCKER SWITCH, DPDT, 4 AMP
50	69-1243-948	FRONT PANEL LABEL, 65DM

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

601242498

REPLACEMENT PARTS LIST

SHEET: 13 OF 13

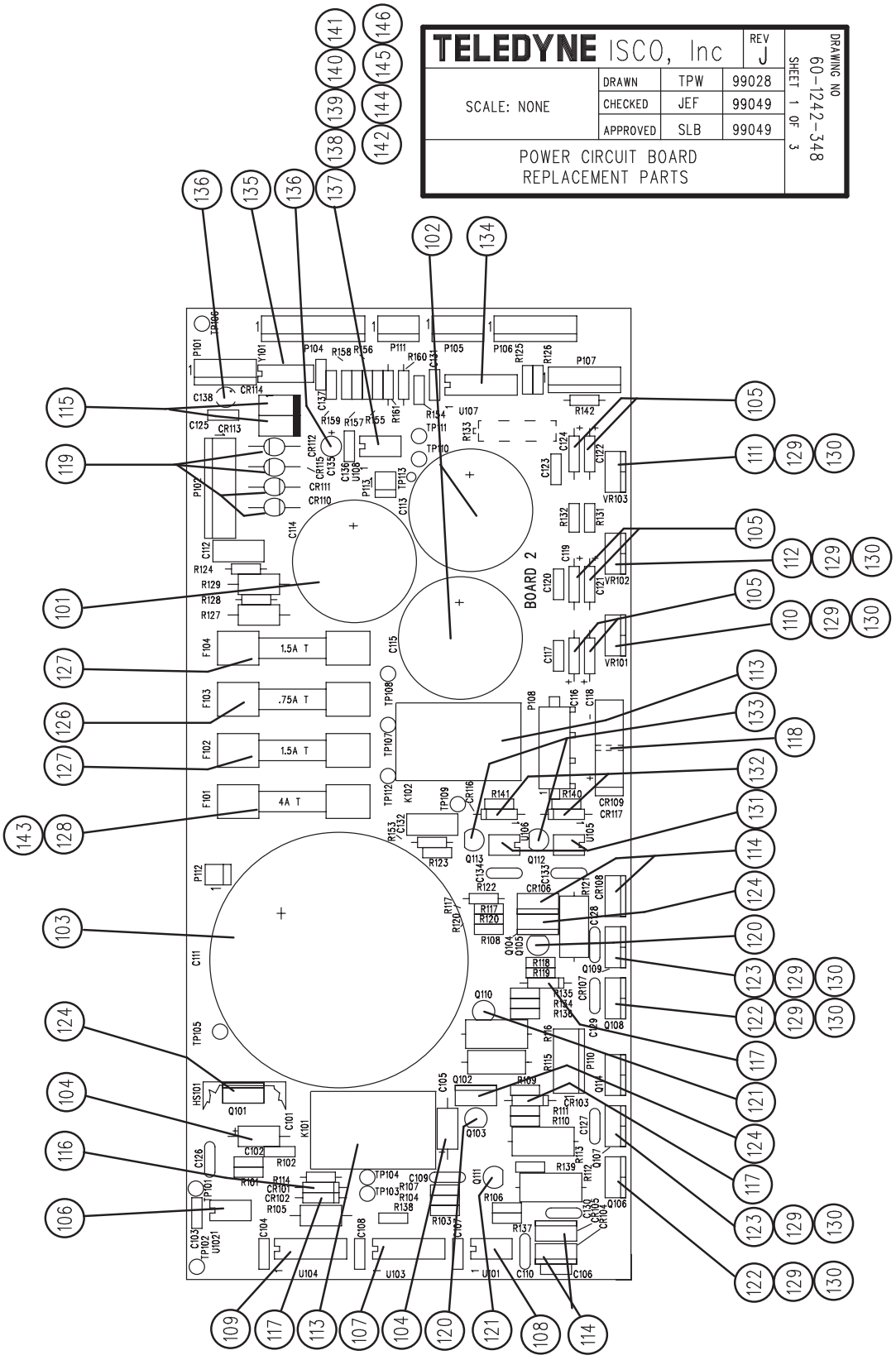
REV:

TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
51	60-1244-235	CALIBRATED PREAMP ASSY
52	69-1243-465	CYLINDER CAP SEAL
53	60-1243-291	DELRIN PLUG
54	231-2007-04	SET SCREW, 1/4-20 X 1/4, CUP POINT

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

A.1.7 Power Circuit Board



REPLACEMENT PART LIST
TELEDYNE ISCO, Inc

POWER CIRCUIT BOARD

DWG NO: 60-1242-348
SHEET: 2 OF 3
REV: J DATE: 110311

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
101	110-4568-01	C114	CAP 6800uF 25VDC
102	110-6333-01	C113 C115	CAP 3300uF 50VDC
103	110-7290-00	C111	CAP 6400uF 150VDC
104	112-5010-00	C101 C105	CAP 2.2uF 20VDC
105	112-7510-00	C116 C118 C119 C121 C122	CAP 1uF 35VDC
		C124	
106	270-0000-01	U102	IC HCPL-2232
107	270-0013-00	U103	IC 4011B
108	270-0129-03	U101	IC LM2903
109	270-2002-00	U104	IC D469
110	279-0200-07	VR101	VR LM7915CT
111	279-0201-05	VR103	VR LM7815C
112	279-0603-01	VR102	VR LM317
113	360-1024-03	K101 K102	RLY SPDT 24VDC 10A
114	400-0151-01	CR104 CR105 CR106 CR108	MUR1515
115	400-0154-01	CR113 CR114	DIO 1N5401
116	400-0914-00	CR101	DIO 1N914
117	400-2152-22	CR102 CR103 CR107	DIO 1N5242B
118	401-0008-00	CR109	KBU8D
119	401-0150-00	CR110 CR111 CR112 CR115	DIO 1N5060
120	402-0237-00	Q103 Q105	XSTR 2N3702
121	402-0237-01	Q110 Q111	XSTR 2N3704
122	402-0640-00	Q106 Q108	XSTR IRF641
123	402-0964-00	Q107 Q109	XSTR IRF9641
124	402-1000-50	Q101 Q102 Q104	XSTR TIP50
126	411-0311-42	F103	FUSE .75A T
127	411-0311-56	F102 F104	FUSE 1.5A T
128	411-0312-70	F101	FUSE 4A T
143	411-0322-75	F101	FUSE 5A FAST-BLO(65HP & 500HP PUMP ONLY)

NOTE: This list subject to change without notice.

REPLACEMENT PART LIST
TELEDYNE ISCO, Inc

POWER CIRCUIT BOARD

DWG NO: 60-1242-348
SHEET: 3 OF 3
REV: J DATE: 110311

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
129	409-9006-00		WSHR NYL DF137A
130	409-9005-03		INSUL SLCON TO220
131	279-0601-04	U105 U106	IC H74A1
132	400-2152-08	CR116 CR117	DIO 1N5234B
133	402-9270-00	Q112 Q113	XSTR 2N7000
134	270-0474-01	U107	IC 74HC14
135	170-1000-15	Y101	XTAL SG-531 1.8432 MHz
136	112-6010-00	C135 C138	CAP 10UF 25V TANT
137	60-1245-151	U108	CODED PUMP ID CHIP 65D, 65HP
138	60-1245-152	U108	CODED PUMP ID CHIP 100DM
139	60-1245-153	U108	CODED PUMP ID CHIP 100DX
140	60-1245-154	U108	CODED PUMP ID CHIP 260D
141	60-1245-155	U108	CODED PUMP ID CHIP 500D
142	60-1245-156	U108	CODED PUMP ID CHIP 1000D
144	410-3000-00	U108	SW SPST X 4 (500HP PUMP ONLY)
145	60-1245-173	U108	CODED PUMP ID CHIP 260HP
146	60-1245-177	U108	CODED PUMP ID CHIP 65DM

NOTE: This list subject to change without notice.

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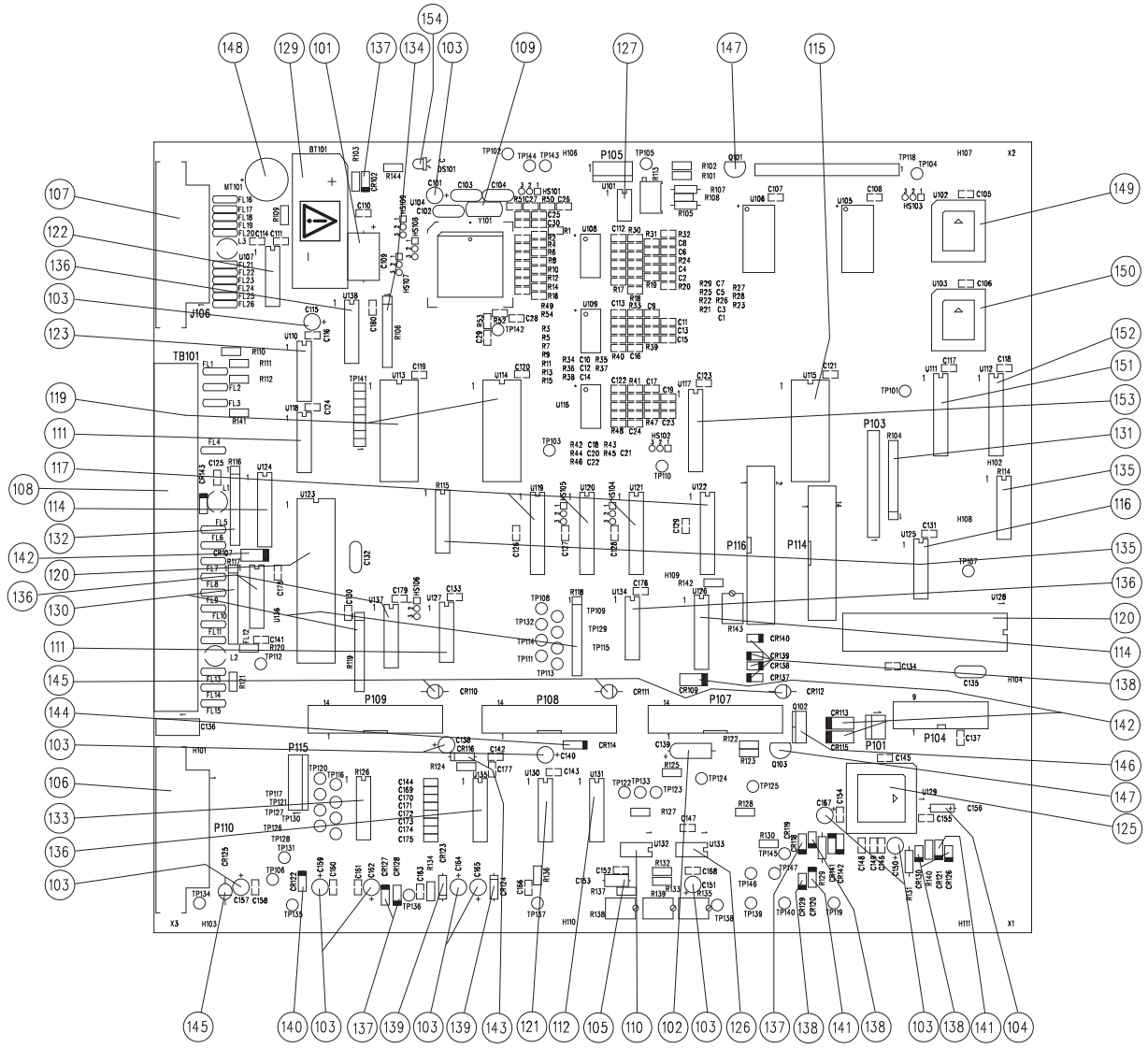
A.1.8 Controller Circuit Board



REVISIONS					
CHG	AUTHORITY	DESCRIPTION	BY	CHKD	DATE
–	–	CREATED, REPLACES 60-1242-257.	MAV	EB	99112
A	99-132	ADD ITEM 154; REMOVE CR101; ADD LABEL TO ITEM 129.	MAV		99197
B	99-228	ITEM 152 WAS 60-1245-094.	TPW	JEF	99300
C	01-0004	RMV ITEM 149,150 ON SHT 3.	TPW	JEF	01082
D	04-0503	UPDATE TO REFLECT PCB CHANGES.	TPW	JEF	05006
E	05-0656	REMOVE ITEM 118 & 128.	TPW	JEF	05355
F	08-0189	REMOVE ITEM 113 & 124.	MAV		050508

CONTROLLER CIRCUIT BOARD

(REF: 69-1263-023)

TELEDYNE ISCO, Inc			REV F
SCALE: NONE	DRAWN	MAV	99004
	CHECKED	JEF	99132
	APPROVED	JEF	99132
CONTROLLER CIRCUIT BOARD REPLACEMENT PARTS			DRAWING NO. 60-1242-345 SHEET 1 OF 3

REPLACEMENT PART LIST
Teledyne Isco, Inc

CONTROLLER CIRCUIT BOARD

DWG NO: 60-1242-345
SHEET: 2 OF 3
REV: F DATE: 050508

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
101	110-6342-00	C109	CAP 30uF 50VDC
102	112-2569-00	C139	CAP 56uF 6VDC
103	112-6010-00	C101 C115 C138 C140 C150	CAP 10uF 25VDC
		C151 C157 C159 C162 C164	
		C165 C167	
104	112-7510-00	C156	CAP 1uF 35VDC
105	119-0306-00	C153	CAP 100pF 600VDC
106	140-1035-02	P110	PLUG 25 PIN SUB D RA
107	141-9002-24	J106	SKT 25 PIN SUB D RA
108	143-2022-00	TB101	TERMINAL BLOCK 22 POS
109	170-1000-05	Y101	XTAL 12.0000 MHZ
110	270-0103-00	U132	IC LF353
111	270-0409-00	U118 U127	IC 74AC04
112	270-0606-00	U131	IC 14504B
114	270-0803-01	U124 U126	IC 2803
115	270-1002-07	U115	IC 74HC154
116	270-1100-04	U125	IC 74HC393
117	270-1110-01	U119 U120 U121 U122	IC LS7166
119	270-1300-34	U113 U114	IC 82C54
120	270-1300-37	U123 U128	IC 82C55A-2
121	270-1400-02	U130	IC 4051B
122	270-1500-04	U107	IC DS14C88
123	270-1500-05	U110	IC DS14C89A
125	271-1650-16	U129	IC CS5016
126	270-1900-08	U133	IC REF-02EZ
127	270-1900-09	U101	IC ICL7665

NOTE: This list subject to change without notice.

REPLACEMENT PART LIST
Teledyne Isco, Inc

CONTROLLER CIRCUIT BOARD

DWG NO: 60-1242-345
SHEET: 3 OF 3
REV: F DATE: 050508

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
129	340-2012-02	BT101	BATTERY 2.4V ⚠ REPLACE WITH SAME TYPE.
130	373-4010-60	R117 R118 R119	RES 9 X 10K
131	379-5001-70	R104	RES 5 X 10K
132	379-5027-50	R116	RES 9 X 2.7K
133	379-5047-40	R126	RES 8 X 470
134	379-5047-60	R106	RES 8 X 47K
135	379-5082-40	R114 R115	RES 8 X 820
136	400-0720-00	U134 U135 U136 U137 U138	IC SP720
137	400-0158-17	CR102 CR118 CR127 CR128	DIO 1N5817
138	400-0914-00	CR119 CR126 CR129 CR130 CR137	DIO 1N914
		CR138 CR139 CR140	
139	400-2152-01	CR123 CR124	DIO 1N5229B
140	400-2152-02	CR122	DIO 1N5232B
141	400-2152-11	CR120 CR121	DIO 1N5230B
142	400-2152-19	CR107 CR109 CR113 CR115	DIO 1N5259B
143	400-2152-21	CR116	DIO 1N5225B
144	400-2152-22	CR114	DIO 1N5242B
145	401-0150-00	CR110 CR111 CR112 CR125	DIO 1N5060
146	402-9120-01	Q102	XSTR MTP12N06
147	402-9270-00	Q101 Q103	XSTR 2N7000
148	490-0050-03	MT101	XDCR AUDIO
149		U102	WHEN ORDERING THIS PART, GIVE THE 9-DIGIT PART NUMBER AND THE PROGRAM REVISION LETTER FROM THE PARTS LABEL.
150		U103	WHEN ORDERING THIS PART, GIVE THE 9-DIGIT PART NUMBER AND THE PROGRAM REVISION LETTER FROM THE PARTS LABEL.
151		U111	IC GAL WHEN ORDERING THIS PART, GIVE THE 9-DIGIT PART NUMBER AND THE PROGRAM REVISION LETTER FROM THE PARTS LABEL.
152		U112	IC GAL WHEN ORDERING THIS PART, GIVE THE 9-DIGIT PART NUMBER AND THE PROGRAM REVISION LETTER FROM THE PARTS LABEL.
153		U117	IC GAL WHEN ORDERING THIS PART, GIVE THE 9-DIGIT PART NUMBER AND THE PROGRAM REVISION LETTER FROM THE PARTS LABEL.
154	400-9130-20	DS101	LED HLMP-1302 RED

NOTE: This list subject to change without notice.

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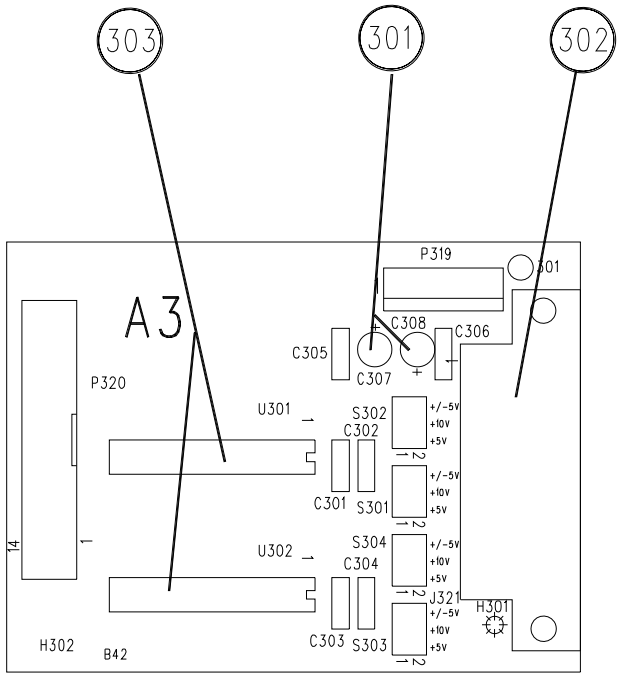
A.1.9 Analog Output Circuit Board



ANALOG OUTPUT CIRCUIT BOARD

REPLACEMENT PART LIST
Isco, Inc

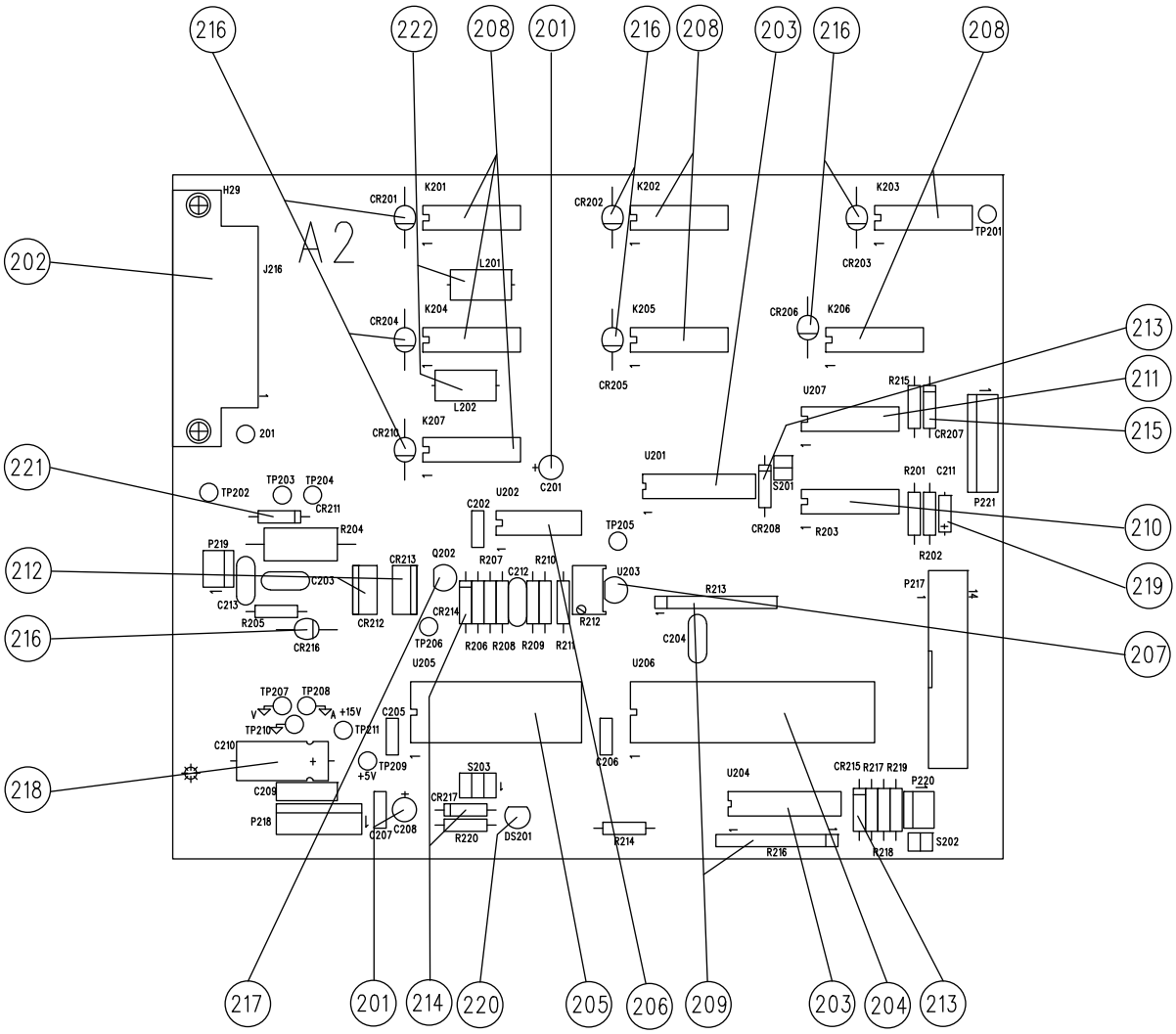
ANALOG OUTPUT CIRCUIT BOARD

DWG NO: 60-1242-275
SHEET: 2 OF 2
REV: DATE: 92050

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
301	112-6010-00	C307 C308	CAP 10uF 25VDC
302	141-9002-26	J321	SKT 25 PIN SUB D RA
303	270-1600-27	U301 U302	IC AD7237

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department, (800) 228-4250.
2. This list subject to change without notice.

A.1.10 Interface Circuit Board



REPLACEMENT PART LIST
Isco, Inc

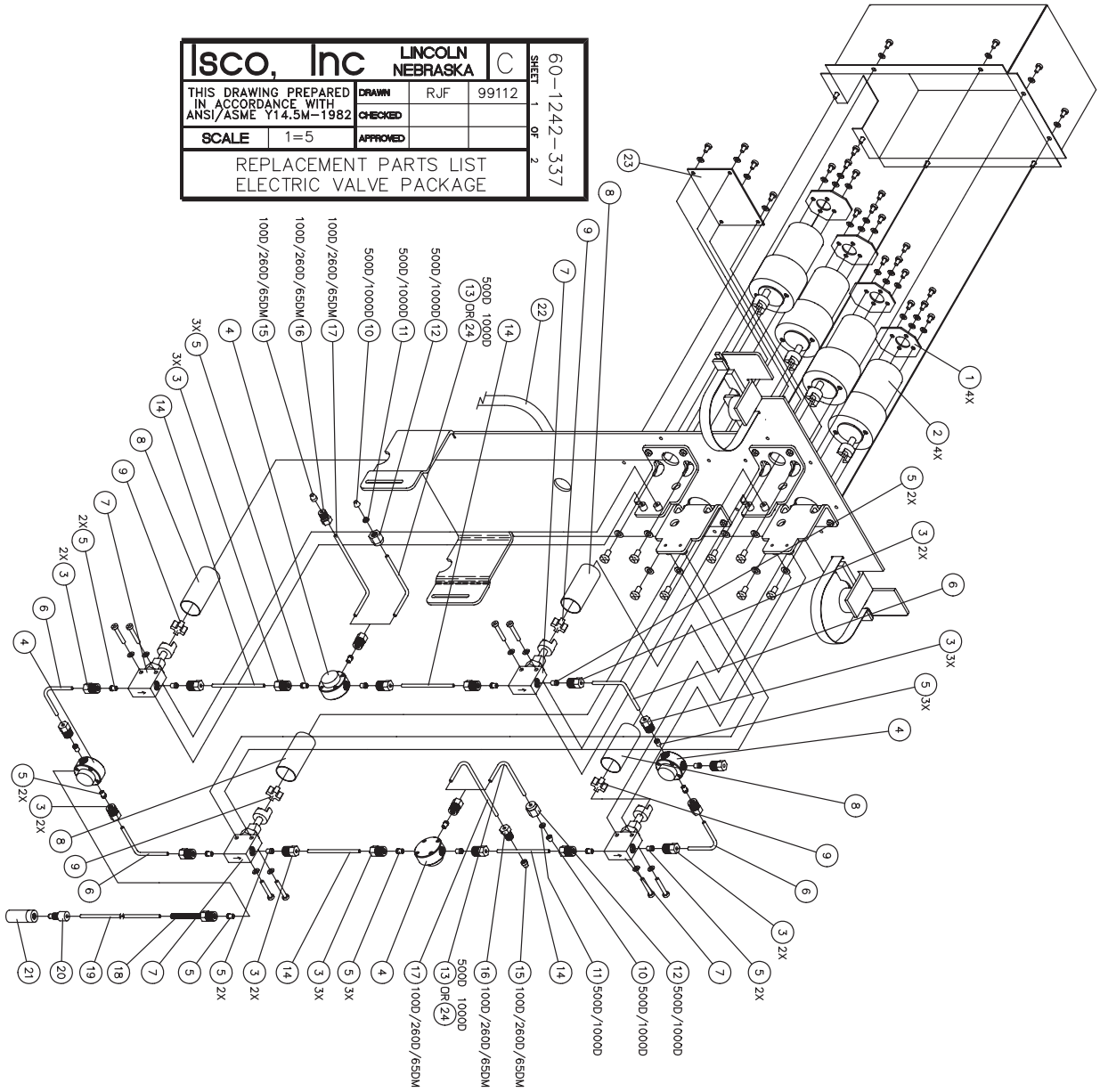
INTERFACE CIRCUIT BOARD

DWG NO: 60-3932-002
SHEET: 2 OF 2
REV: A DATE: 99100

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
201	112-6010-00	C201 C208	CAP 10uF 25VDC
202	141-9002-27	J216	SKT 25 PIN D-SUB RTANG
203	270-0803-01	U201 U204	IC 2803
204	270-1300-37	U206	IC 82C55A-2
205	270-1300-40	U205	IC DS1286
206	270-0103-24	U202	IC LM324
207	279-0205-07	U203	IC VREF 336 2.5V
208	365-3012-00	K201 K202 K203 K204 K205	RLY DPDT 12VDC
		K206 K207	
209	379-5027-50	R213 R216	RES 9 X 2.7K
210	379-5027-51	R203	RES 8 X 2.7K
211	400-0720-00	U207	IC SP720
212	400-0151-01	CR212 CR213	DIO MUR1520
213	400-2022-00	CR208 CR215	DIO ZENER 22V 1N4748A
214	400-2152-08	CR214 CR217	DIO ZENER 6.2V 1N5234B
215	400-2152-11	CR207	DIO ZENER 4.7V 1N5230B
216	401-0150-00	CR201 CR202 CR203 CR204 CR205	DIO 1N5060
		CR206 CR210 CR216	
217	402-9270-00	Q202	XSTR 2N7000
218	110-6310-00	C210	CAP 100uF 50VDC
219	112-5005-00	C211	CAP 1.0uF 20VDC
220	130-0004-00	DS201	LED MV5753 RED
221	400-2152-22	CR211	DIO ZENER 12V 1N5242B
222	60-0854-042	L201 L202	INDUCTOR ASSY

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department, (800) 228-4250.
2. This list subject to change without notice.

A.1.11 Dual Electric Valve Package



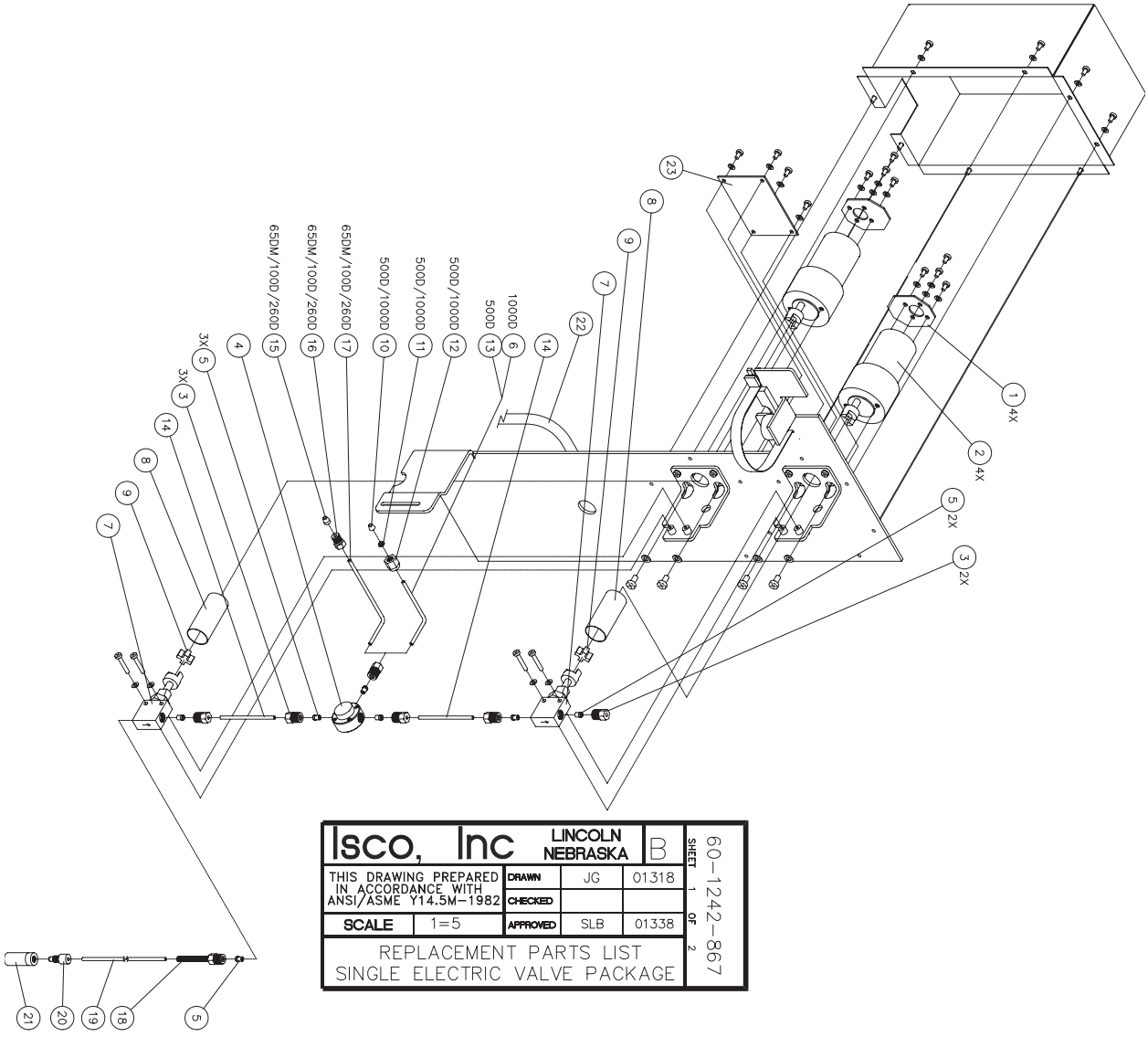
REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–337
SHEET: 2 OF 2
REV.: C DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
1	60–3934–002	MOTOR CIRCUIT BOARD ASSY
2	60–1243–012	MOTOR ASSY W/ COUPLER
3	209–0169–44	GLAND NUT, 1/8 TUBING, SSI
4	60–1243–737	TEE, 1/8 TUBING (INCLUDES ITEMS 3 & 5)
5	209–0163–53	FERRULE, 1/8 ID, HASTELLOY, SSI
6	60–1243–740	TUBING, 1/8 OD, 1.6 X 1.6
7	60–1244–313	VALVE ASSY, 1/8 TUBING (INCLUDES ITEMS 3 & 5)
8	60–3933–061	COUPLING SHIELD
9	60–3933–010	SPIDER
10	209–0169–10	FRONT FERRULE, 1/8 ID FOR 500D/1000D VALVE PKG
11	209–0169–11	BACK FERRULE, 1/8 ID FOR 500D/1000D VALVE PKG
12	209–0170–04	FITTING NUT, 1/8 TBG FOR 500D/1000D VALVE PKG
13	60–1243–742	TUBING, 1/8 OD, 1.4 X 2.2 FOR 500D VALVE PKG
14	60–1243–746	TUBING, 1/8 OD, 2.6 LONG
15	209–0163–60	FERRULE, 1/8 ID FOR 100D/260D VALVE PKG
16	209–0169–27	NUT, 1/8 TUBING FOR 100D/260D VALVE PKG
17	60–1243–741	TUBING, 1/8 OD, 1.4X3.4 FOR 100D/260D VALVE PKG
18	60–1248–157	NUT ASSY
19	60–1243–557	TUBING, TEFLON, .085 ID, 60 INCHES LONG
20	209–0169–81	MALE NUT, 1/8 TUBING
21	209–0169–80	FILTER, 10 MICRON
22	60–1244–312	MAIN HARNESS
23	69–1244–348	SENSOR CIRCUIT BOARD ASSY
24	69–1243–827	TUBING, 1/8 OD, 1.4 X 1.9 FOR 1000D VALVE PKG

NOTE: 1. This list is subject to change without notice.

A.1.12 Single Electric Valve Package



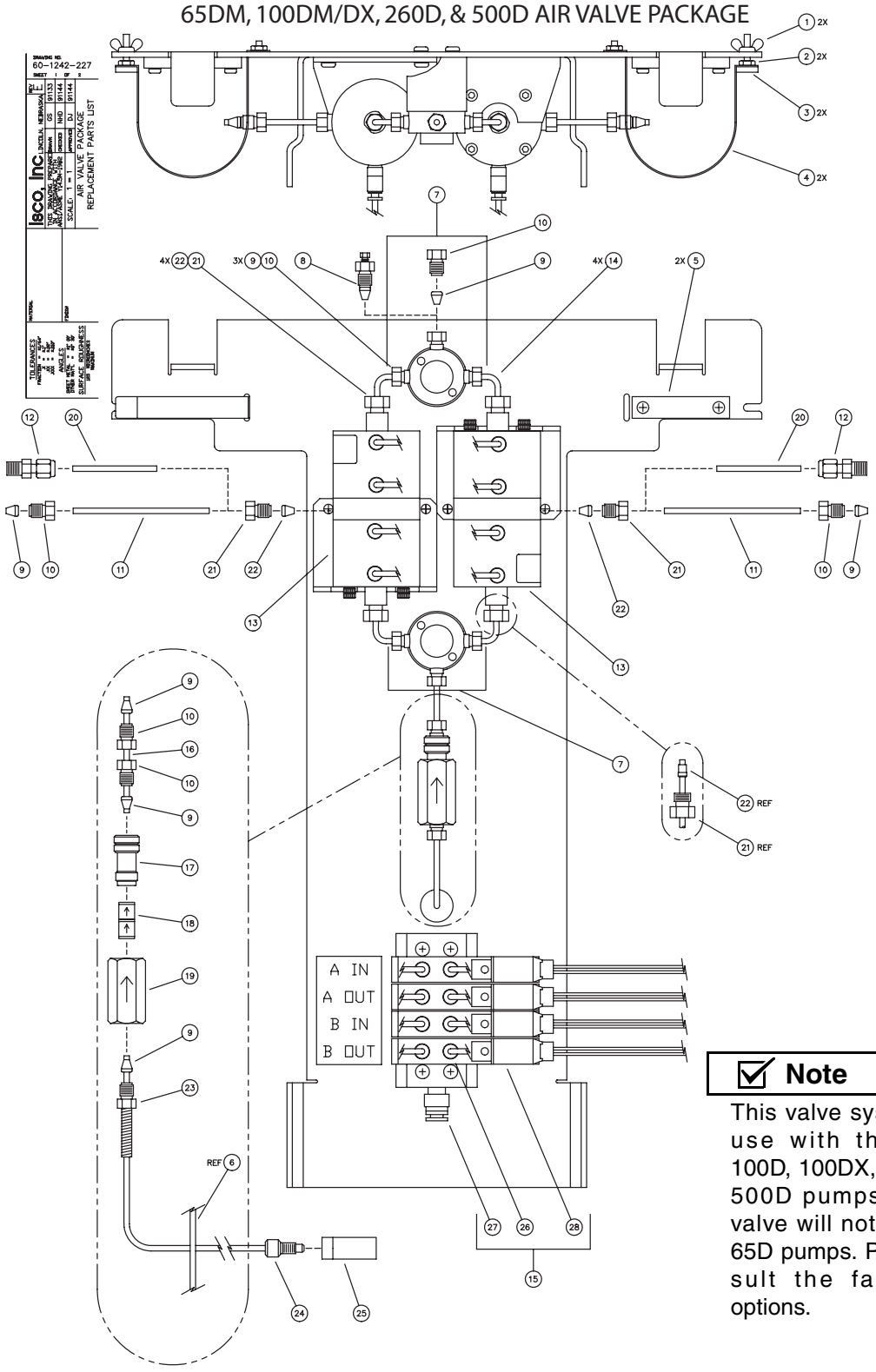
REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–867
SHEET: 2 OF 2
REV.: B DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
1	60–3934–002	MOTOR CIRCUIT BOARD ASSY
2	60–3934–012	MOTOR ASSY W/ COUPLER
3	209–0169–44	GLAND NUT, 1/8 TUBING, SSI
4	60–1243–737	TEE, 1/8 TUBING (INCLUDES ITEMS 3 & 5)
5	209–0163–53	FERRULE, 1/8 ID, HASTELLOY, SSI
6	60–1243–827	TUBING, 1/8 OD, 1.4 X 1.9
7	60–1244–313	VALVE ASSY, 1/8 TUBING (INCLUDES ITEMS 3 & 5)
8	60–3933–061	COUPLING SHIELD
9	60–3933–010	SPIDER
10	209–0169–10	FRONT FERRULE, 1/8 ID FOR 500D VALVE PKG
11	209–0169–11	BACK FERRULE, 1/8 ID FOR 500D VALVE PKG
12	209–0170–04	FITTING NUT, 1/8 TUBING FOR 500D VALVE PKG
13	60–1243–742	TUBING, 1/8 OD, 1.4 X 2.2 FOR 500D VALVE PKG
14	60–1243–746	TUBING, 1/8 OD, 2.6 LONG
15	209–0163–60	FERRULE, 1/8 ID FOR 100D/260D VALVE PKG
16	209–0169–27	NUT, 1/8 TUBING FOR 100D/260D VALVE PKG
17	60–1243–741	TUBING, 1/8 OD, 1.4X3.4 FOR 100D/260D VALVE PKG
18	60–1248–157	NUT ASSY
19	60–1243–557	TUBING, TEFLON, .085 ID, 60 INCHES LONG
20	209–0169–81	MALE NUT, 1/8 TUBING
21	209–0169–80	FILTER, 10 MICRON
22	60–1244–312	MAIN HARNESS
23	69–1244–348	SENSOR CIRCUIT BOARD ASSY

NOTE: 1. This list is subject to change without notice.

A.1.13 SST Dual Air Valve Package for 100/260D/500D



Note

This valve system is for use with the 65DM, 100D, 100DX, 260D, and 500D pumps. This air valve will not work with 65D pumps. Please consult the factory for options.

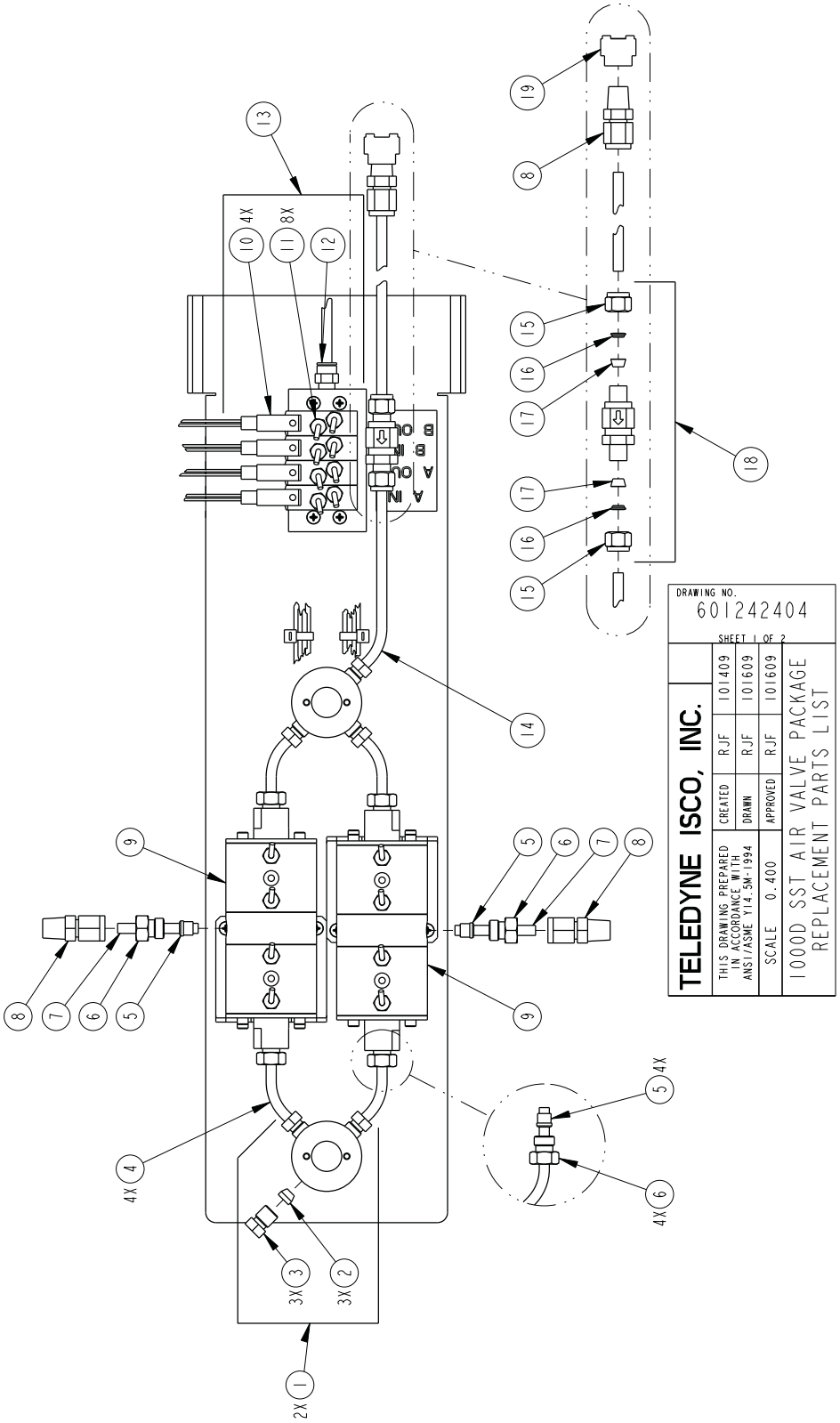
REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–227
SHEET: 2 OF 2
REV.: E DATE: 03122

ITEM NO.	PART NUMBER	DESCRIPTION
1	232–4040–00	WINGNUT
2	232–1140–02	NUT
3	60–1248–101	STRAP MOUNT
4	60–1243–545	STRAP
5	60–1243–553	SPACER BLOCK
6		
7	209–0161–36	1/8 OD TUBING UNION TEE WITH FITTING (VALCO)
8	209–0169–42	1/8 TO 1/16 OD TUBING REDUCER UNION (VALCO)
9	209–0169–41	1/8 OD TUBING FERRULE ZERO VOLUME (VALCO)
10	209–0169–27	1/8 OD TUBING COLUMN NUT (VALCO)
11	60–1243–529	TUBING
12	209–0161–01	1/8 NPT TO 1/8 TUBING MALE CONNECTOR (SWAGELOK)
13	69–1243–572	3 WAY VALVE
14	60–1243–569	TUBING
15	69–1243–574	AIR ACTUATOR
16	60–1243–570	TUBING
17	60–2253–240	CHECK VALVE HOUSING INLET (ANALYTICAL STANDARD INLET)
18	60–3864–010	CHECK VALVE CARTRIDGE
19	60–1243–516	SINGLE CHECK VALVE HOUSING
20	60–1243–544	TUBING
21	209–0161–44	COMPRESSION NUT, SPEEDBITE
22	209–0161–43	1/8 FERRULE, SPEEDBITE
23	60–2258–019	NUT ASSEMBLY
24	209–0169–81	1/8 OD TUBING NUT (UPCHURCH)
25	209–0169–80	10 MICRON FILTER (ANALYTICAL INERT) (UPCHURCH)
26	209–0161–72	1/8 OD TUBE FITTING
27	209–0161–73	1/4 OD TUBE FITTING
28	209–0093–26	SOLENOID VALVE

NOTE: 1. This list is subject to change without notice.

A.1.14 SST Dual Air Valve Package for 1000D



601242404

REPLACEMENT PARTS LIST

SHEET: 2 OF 2

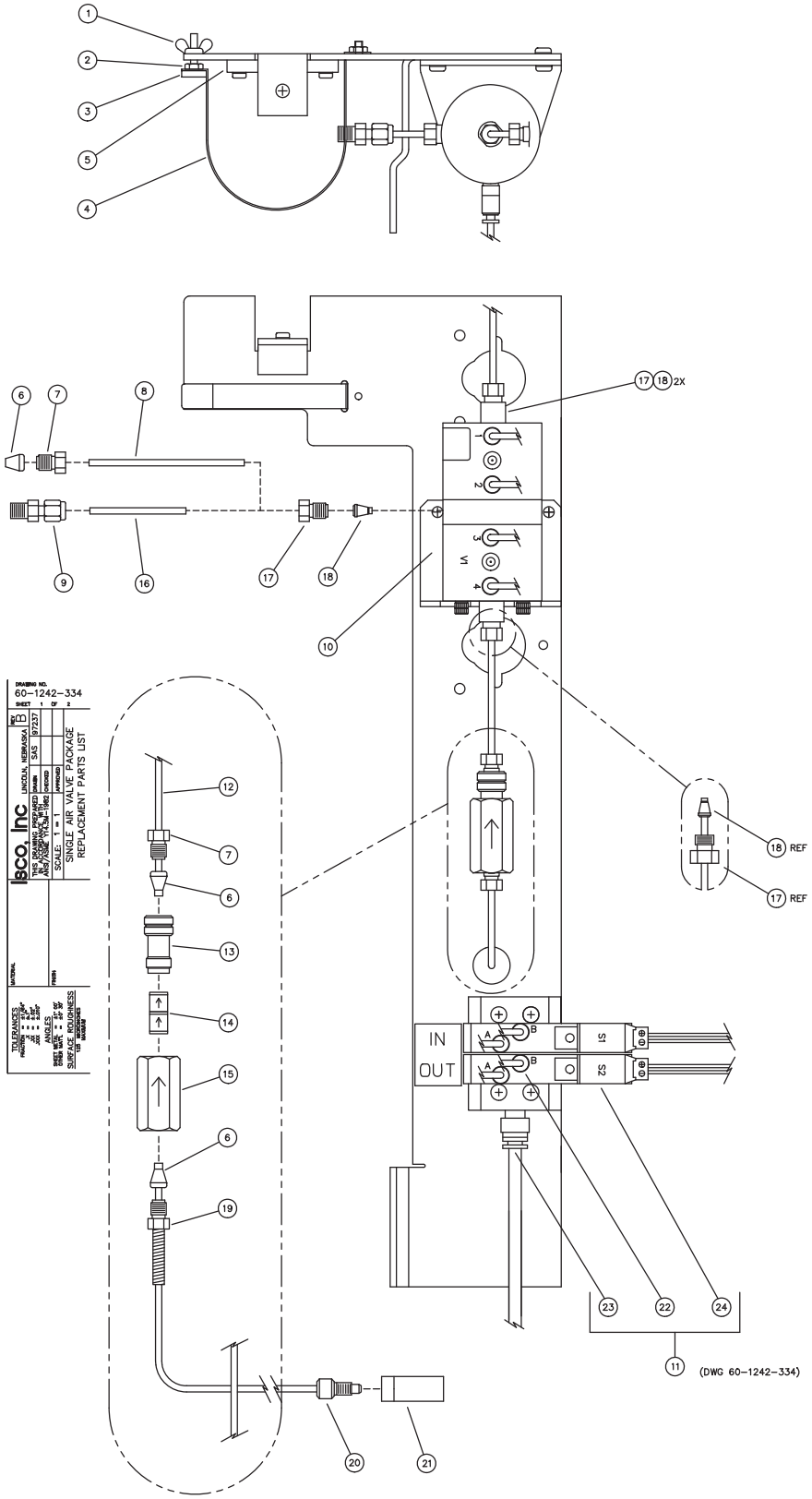
REV:

TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
1	209016382	1/4 OD SST TUBING TEE W/ FITTINGS (VALCO)
2	209016384	1/4 OD SST TUBING FERRULE (VALCO)
3	209016383	1/4 OD TUBING NUT (VALCO)
4	601243891	TEE TO VALVE STAINLESS STEEL TUBING
5	209016569	1/4 OD HST TUBING FERRULE, SPEEDBITE
6	209016568	1/4 OD GLAND NUT, SPEEDBITE
7	601243893	VALVE TO PUMP STAINLESS STEEL TUBING
8	209016336	1/4 NPT TO 1/4 TUBING SST MALE CONN
9	691243578	3 WAY HASTELLOY VALVE W/ FITTINGS
10	209009326	SOLENOID VALVE
11	209016172	1/8 OD TUBE FITTING
12	209016173	1/8 NPT TO 1/4 OD TUBE FITTING
13	691243574	AIR ACTUATOR
14	601243892	TEE TO CHECK VALVE SST TUBING
15	209016966	1/4 OD TUBING NUT (SWAGELOK)
16	209016369	1/4 SST BACK TBG FERRULE (SWAGELOK)
17	209016368	1/4 SST FRONT TBG FERRULE (SWAGELOK)
18	209016406	CHECK VALVE W/ FITTINGS (SWAGELOK)
19	601248184	INLET FILTER ASSEMBLY

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

A.1.15 Single Air Valve Package



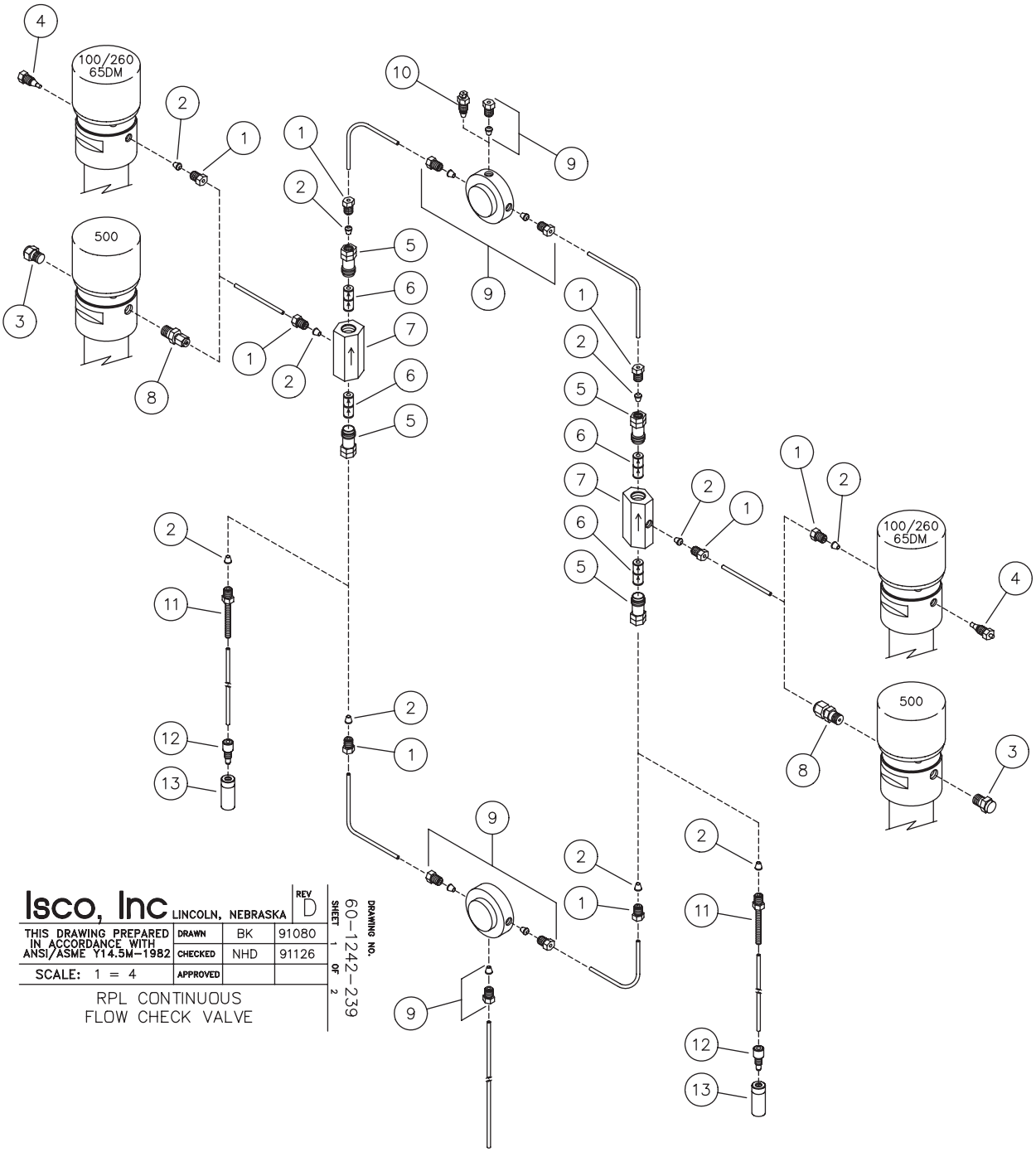
REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–334
SHEET: 2 OF 2
REV.: B DATE: 03122

ITEM NO.	PART NUMBER	DESCRIPTION
1	232–4040–00	WINGNUT
2	232–1140–02	NUT
3	60–1248–101	STRAP MOUNT
4	60–1243–545	STRAP
5	60–1243–553	SPACER BLOCK
6	209–0169–41	1/8 OD TUBING FERRULE ZERO VOLUME (VALCO)
7	209–0169–27	1/8 OD TUBING COLUMN NUT (VALCO)
8	60–1243–529	TUBING
9	209–0161–01	1/8 NPT TO 1/8 TUBING MALE CONNECTOR (SWAGELOK)
10	69–1243–572	3 WAY VALVE
11	69–1243–729	AIR ACTUATOR
12	60–1243–570	TUBING
13	60–2253–240	CHECK VALVE HOUSING INLET (ANALYTICAL STANDARD INLET)
14	60–3864–010	CHECK VALVE CARTRIDGE
15	60–1243–516	SINGLE CHECK VALVE HOUSING
16	60–1243–544	TUBING
17	209–0161–44	COMPRESSION NUT, SPEEDBITE
18	209–0161–43	1/8 FERRULE, SPEEDBITE
19	60–2258–019	NUT ASSEMBLY
20	209–0169–81	1/8 OD TUBING NUT (UPCHURCH)
21	209–0169–80	10 MICRON FILTER (ANALYTICAL INERT) (UPCHURCH)
22	209–0161–72	1/8 OD TUBE FITTING
23	209–0161–73	1/4 OD TUBE FITTING
24	209–0093–26	SOLENOID VALVE

NOTE: 1. This list is subject to change without notice.

A.1.16 Dual Check Valve Package for 100/260/500D



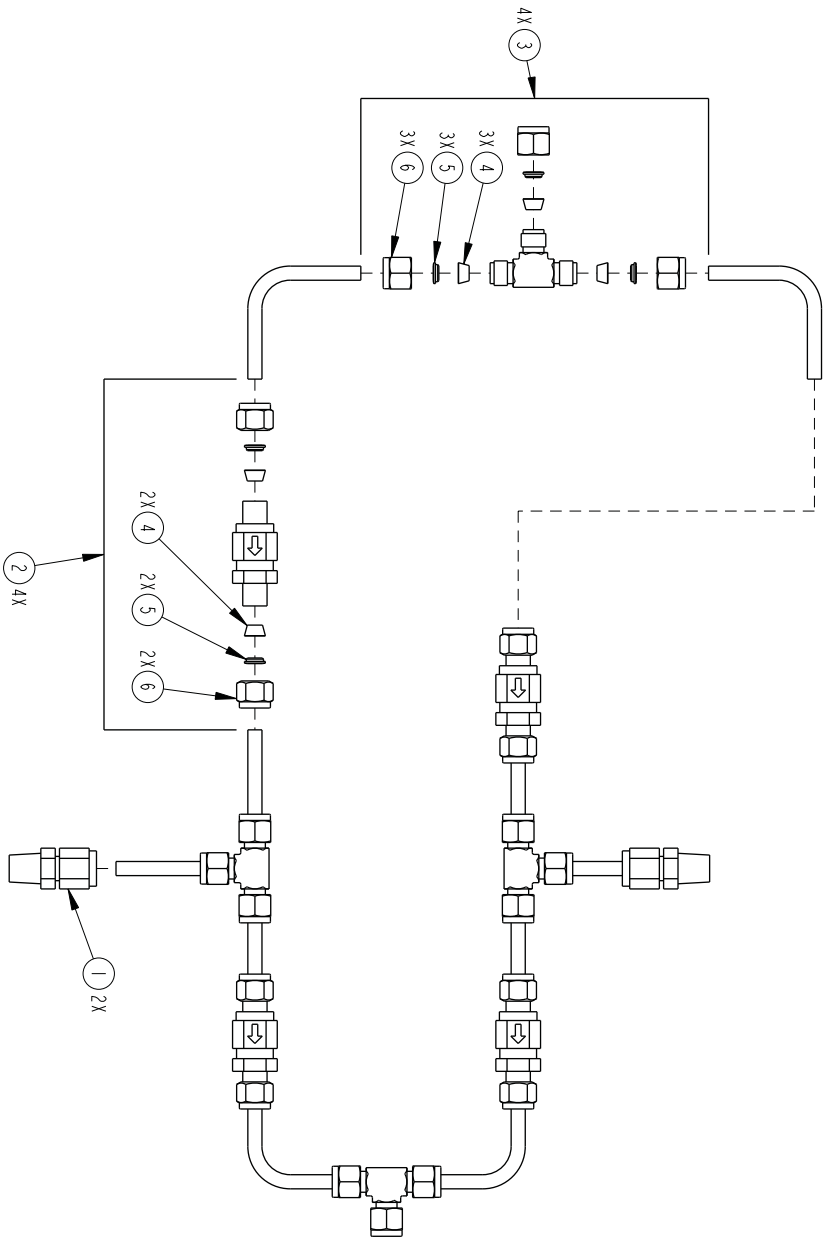
REPLACEMENT PARTS LIST
Isco, Inc.

DWG. NO.: 60–1242–239
SHEET: 2 OF 2
REV.: D DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
1	209–0169–27	NUT
2	209–0169–41	FERRULE
3	209–0168–00	PIPE PLUG
4	209–0166–80	PLUG 1/8 SST HP
5	60–2253–240	CHECK VALVE HOUSING
6	60–3864–010	CHECK VALVE CARTRIDGE
7	60–1243–517	DOUBLE CHECK VALVE HOUSING
8	209–0161–01	MALE CONNECTOR
9	209–0161–36	1/8 UNION TEE
10	209–0169–42	TUBING REDUCER CONNECTOR
11	60–2258–019	NUT ASSEMBLY
12	209–0169–81	TUBING NUT
13	209–0169–80	FILTER

Note: 1. For current prices and quotations on parts, contact Isco Service Department, (800) 228–4250
2. This list is subject to change without notice.

A.1.17 Dual Check Valve Package for 1000D



TELEDYNE ISCO, INC.				DRAWING NO. 60536201
THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI/ASME Y14.5M-1994	CREATED	RJF	020110	SHEET 1 OF 2
	DRAWN	RJF	020110	
SCALE 0.500	APPROVED	RJF	020110	
REPLACEMENT PARTS LIST, DUAL CHECK VALVE PKG, 1000D				

605362011

REPLACEMENT PARTS LIST

SHEET: 2 OF 2

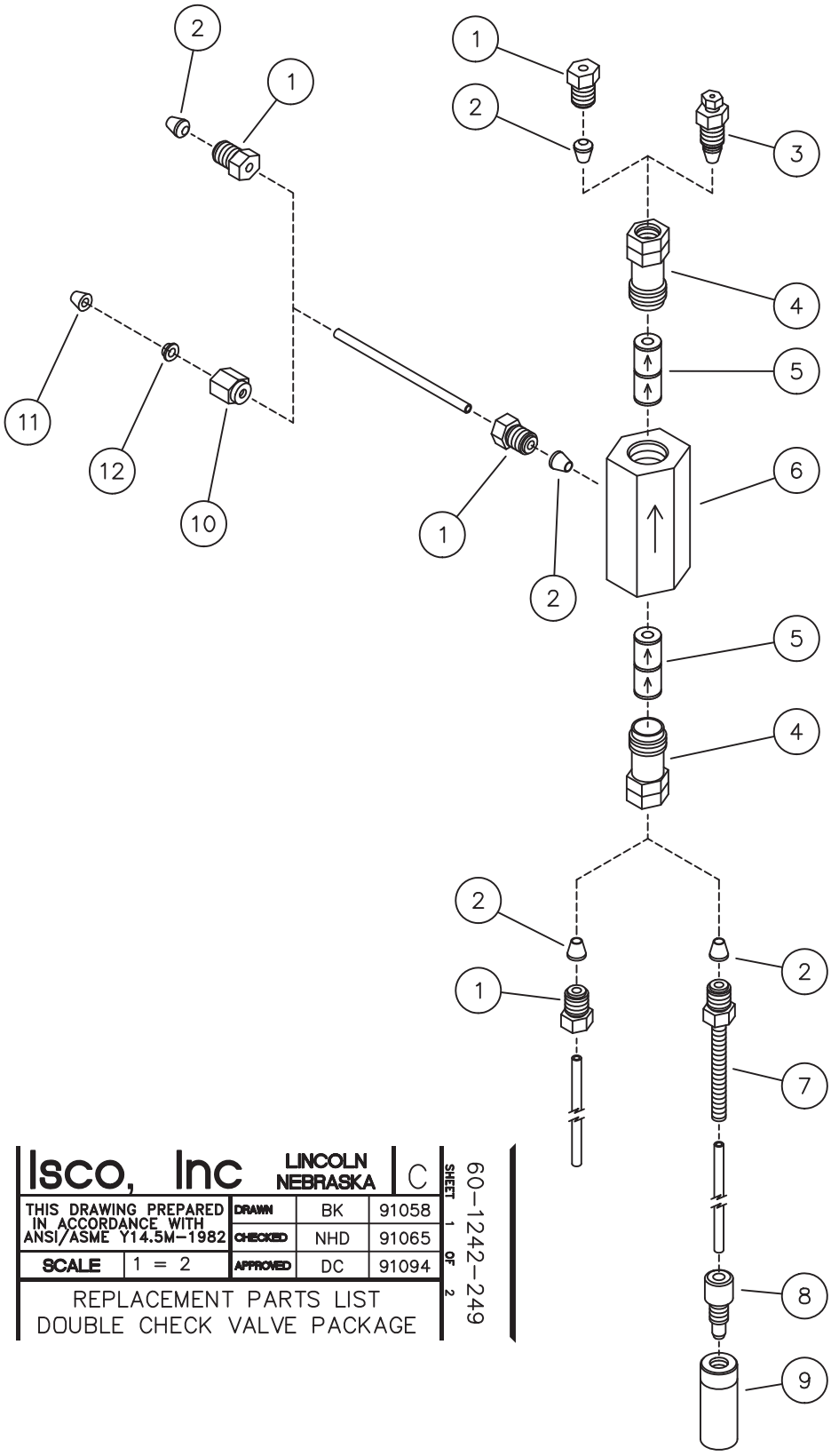
REV:

TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
1	209-0163-36	1/4 NPT TO 1/4 TBG SST MALE CONN
2	209-0164-06	CHECK VALVE W/ FITTINGS (SWAGELOK)
3	209-0168-15	1/4 SST TBG TEE W/ FITTING (SWAGELOK)
4	209-0163-68	1/4 SST FRONT TBG FERRULE (SWAGELOK)
5	209-0163-69	1/4 SST BACK TBG FERRULE (SWAGELOK)
6	209-0169-66	1/4 OD TUBING NUT (SWAGELOK)

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

A.1.18 Single Check Valve Package



Isco, Inc	LINCOLN NEBRASKA	C	SHEET 1 OF 2	60-1242-249
THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI/ASME Y14.5M-1982	DRAWN	BK	91058	
	CHECKED	NHD	91065	
SCALE 1 = 2	APPROVED	DC	91094	
REPLACEMENT PARTS LIST DOUBLE CHECK VALVE PACKAGE				

REPLACEMENT PARTS LIST
Isco, Inc.

DWG. NO.: 60–1242–249
SHEET: 2 OF 2
REV.: C DATE: 03122

ITEM NO.	PART NUMBER	DESCRIPTION
1	209–0169–27	NUT
2	209–0169–41	FERRULE
3	209–0169–42	TUBING REDUCER CONNECTOR
4	60–2253–240	CV HOUSING INLET (ANALYTICAL STANDARD INERT)
5	60–3864–010	CHECK VALVE CARTRIDGE
6	60–1243–517	DOUBLE CV HOUSING
7	60–2258–019	NUT ASSY
8	209–0169–81	TUBING NUT
9	209–0169–80	FILTER (ANALYTICAL STANDARD INERT)
10	209–0169–00	NUT
11	209–0169–10	FRONT FERRULE
12	209–0169–11	BACK FERRULE

Note: 1. For current prices and quotations on parts, contact Isco Service Department, (800) 228–4250
2. This list is subject to change without notice.

D Series Syringe Pumps

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NOTICE

Disregard the following “Declaration of Conformity” and Radio Interference Statement” if your instrument does not have a CE label on its rear panel

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.

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.

DECLARATION OF CONFORMITY

CE
ISM1-A

Application of Council Directive:	89/336/EEC – The EMC Directive 73/23/EEC – The Low Voltage Directive
Manufacturer's Name:	Teledyne Isco, Inc.
Manufacturer's Address:	4700 Superior, Lincoln, Nebraska 68504 USA Mailing Address: P.O. Box 82531, Lincoln, NE 68501
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments
Trade Name/Model No:	Series D Series Controller/Pump Controller
Year of Issue:	1999
Standards to which Conformity is Declared:	EN 61326-1998 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use EN 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	B B
EN61000-4-3	Radiated RF Immunity	80 MHz to 1000MHz 80% AM at 1kHz Level 1 - 1 V/m	A
EN61000-4-4	Electrical Fast Transient	Level 2 - 1kV on ac lines	B
EN61000-4-5	Surge on AC Lines	2kV common mode, 1kV differential mode	B
EN61000-4-6	Conducted RF on AC lines	150 kHz to 80 MHz, 3V rms, 80% modulated	B
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	
EN61000-3-2, 3-3	Harmonic Flicker	Group1, Class A	

I, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of July 12, 1999.

Williaml Foster
USA Representative

TELEDYNE ISCO
A Teledyne Technologies Company

William Foster
Director of Engineering
Teledyne Isco, Inc.
4700 Superior Street
Lincoln, Nebraska 68504

Phone: (402) 464-0231
Fax: (402) 465-3799

60-1242-327
Rev E

DECLARATION OF CONFORMITY

CE
ISM1-A

Application of Council Directive:	89/336/EEC – The EMC Directive 73/23/EEC – The Low Voltage Directive
Manufacturer's Name:	Teledyne Isco, Inc.
Manufacturer's Address:	4700 Superior, Lincoln, Nebraska 68504 USA Mailing Address: P.O. Box 82531, Lincoln, NE 68501
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments:
Trade Name/Model No:	Syringe Pumps: 65D, 65DM, 65DX, 65DXX, 65HP, 100DM, 100DX, 100DX2, 100DX4, 260D, 260HP, 260DX, 260DXX, 260SP, 500D, 500DO, 500DX, 500DXX, 500HP, 500HV,500SP, 1000D, 1000DO, 1000DX, 1000 DXX, 1000HV
Year of Issue:	1999
Standards to which Conformity is Declared:	EN 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use EN 61326-1998 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

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

I, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of July 12, 1999.

William Foster

William Foster
USA Representative

Teledyne Isco Inc.

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

60-1242-328
Rev G

Teledyne Isco One Year Limited Factory Service Warranty*

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

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

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

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

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

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

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

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

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

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

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

Shipping Address: Teledyne Isco, Inc. - Attention Repair Service
4700 Superior Street
Lincoln, NE 68504 USA

Mailing Address: Teledyne Isco, Inc.
PO Box 82531
Lincoln, NE 68501 USA

Phone: Repair service: (800) 775-2965 (lab instruments)
(866) 298-6174 (samplers & flow meters)
Sales & General Information: (800) 228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: IscoService@teledyne.com

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TELEDYNE ISCO
A Teledyne Technologies Company