ReaXus Model 6010R Reciprocating Pump

High Pressure Piston Pump for High Performance Metering

Operation Guide

TELEDYNE ISCO
Everywhereyoulook™

#69-2253-306

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General Warnings

Before installing, operating, or maintaining this equipment, it is imperative that all hazards and preventive measures are fully understood. While specific hazards may vary according to location and application, take heed of the following general warnings:

⚠ WARNING

Liquids associated with this instrument may be classified as carcinogenic, biohazard, 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.

⚠ AVERTISSEMENT

Eviter de répandre des liquides dangereux. Les liquides qui sont analysés dans cet instrument peuvent être cancérigènes, hasards biologiques, inflammables, ou radioactifs. Si vous devez utiliser tels liquides, 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 compagnie qui concerne l'évènement d'un accident avec les matières hasardeuses.

⚠ 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.

⚠ AVERTISSEMENT

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

⚠ WARNING

If this system uses flammable organic solvents, Teledyne Isco recommends that you place this system in a well-ventilated environment, designed for these types of materials. This environment should be constructed in accordance with federal, state, and local regulations. It should also comply with your organization's plan

concerning chemical and hygiene mishaps. In all cases use good laboratory practices and standard safety procedures.

⚠ AVERTISSEMENT

Ce système peut utiliser des dissolvants organiques inflammables. Pour réduire le péril qui peut être causé par l'accumulation des vapeurs explosives, Teledyne Isco recommande que vous installez ce système dans un environnement bien-aéré qui est conçu pour les matières hasardeuses. Cet environnement devrait être construit selon les règlements fédéraux, provinciaux, et locaux. Aussi, il devrait se conformer au plan de votre organisation qui concerne les mésaventures de l'hygiène ou de chimique. En tout cas, utilisez toujours de pratiques bonnes de la laboratoire et des procédures standardes de la sûreté.

Hazard Severity Levels

This manual applies *Hazard Severity Levels* to the safety alerts, These three levels are described in the sample alerts below.

⚠ CAUTION

Cautions identify a potential hazard, which if not avoided, may result in minor or moderate injury. This category can also warn you of unsafe practices, or conditions that may cause property damage.

⚠ WARNING

Warnings identify a potentially hazardous condition, which if not avoided, could result in death or serious injury.

⚠ DANGER

DANGER – limited to the most extreme situations to identify an imminent hazard, which if not avoided, will result in death or serious injury.

Hazard Symbols

The equipment and this manual use symbols used to warn of hazards. The symbols are explained below.

Hazard Symbols	
Warnings and Cautions	
	The exclamation point within the triangle is a warning sign alerting you of important instructions in the instrument's technical reference manual.
	The lightning flash and arrowhead within the triangle is a warning sign alerting you of "dangerous voltage" inside the product.
Symboles de sécurité	
	Ce symbole signale l'existence d'instructions importantes relatives au produit dans ce manuel.
	Ce symbole signale la présence d'un danger d'électocution.
Warnungen und Vorsichtshinweise	
	Das Ausrufezeichen in Dreieck ist ein Warnzeichen, das Sie darauf aufmerksam macht, daß wichtige Anleitungen zu diesem Handbuch gehören.
	Der gepfeilte Blitz im Dreieck ist ein Warnzeichen, das Sei vor "gefährlichen Spannungen" im Inneren des Produkts warnt.
Advertencias y Precauciones	
	Esta señal le advierte sobre la importancia de las instrucciones del manual que acompañan a este producto.
	Esta señal alerta sobre la presencia de alto voltaje en el interior del producto.

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ReaXus Reciprocating Pump

Section 1 Introduction

This operator's manual contains information needed to install, operate, and perform minor maintenance on the ReaXus Pump.

1.1 Description of the ReaXus Pump

The ReaXus pump is designed to be a reliable component within basic analytical or sophisticated research instruments, in routine analyses, or as a dependable metering pump for general laboratory or industrial use.

1.1.1 Specifications

Table 1-1 ReaXus Model 6010R Technical Specifications

Capacity	50.3 µL/stroke
Flow range (ml/min):	0.01 – 10.00 mL/min
Flow accuracy:	≤ ± 2% of set point @ 5-95% of flow range (80:20 Water/IPA @ 1,000 psi) ≤ ± 1.5% @ 1.5 mL/min to 5.0 mL/min (80:20 Water/IPA @ 1,000 psi)
Flow precision:	0.2% RSD
Pressure Pulsation:	≤ 2% peak-to-peak
Displacement resolution:	5.2 nL/step
Pressure range:	413.7 bar (6,000 psi)
Pressure accuracy:	± 2.0% FS
Pressure Zero Offset:	± 2 psi
Wetted materials (standard):	Sapphire, Ruby, SST, UHMWPE, PTFE
Plumbing ports:	1/8” OD tubing inlet standard; 1/8” OD tubing outlet standard
Operating temperature:	10 – 40 °C Ambient
Humidity:	20 to 90%
Altitude:	2000 M
Power required:	45 W, 100-240 Vac, 50-60 Hz
Dimensions (H x W x D):	18 cm x 18 cm x 30 cm (7” x 7” x 12”)
Weight: Pump unit:	7 kg (15lb)
External Control:	RS-232 PC Interface, Micro USB Port, Analog Flow Control Input (0-10V or 4-20 mA), Digital Run & Stop Control via Contact Closure / 5 V TTL
Standards conformity:	CSAUS, CE, RoHS compliant

1.1.2 Pump Features

The ReaXus Pump includes:

- Rapid refill mechanism to reduce pulsation
- Automatic pump shut-off if the pressure exceeds the maximum pressure limit
- User set upper and lower pressure limits
- Integrated prime/purge valve
- 5-digit LED front panel user keypad
- PRIME mode to flush out entrapped air bubbles upon start-up
- Back panel USB and RS-232 serial communication ports for
- Complete control and status
- Remote analog input to control flow rate (0-10V) or (4-20 mA)
- Remote digital inputs for pump control, outputs for fault indication
- Digital stepper motor design that prevents flow rate drift over time and temperature, which is a common problem found in analog design
- Pressure monitoring with transducer
- Self-flushing pump head
- A diaphragm-type pulse damper, which reduces pulsation in the system by as much as 90% and may include an isolated pressure transducer (i.e., the transducer adds no dead volume)
- Outlet Filter

1.1.3 Wetted Materials

Pump heads, check valve bodies, and tubing are made of 316 stainless steel, depending on version ordered. Other common materials are synthetic ruby and sapphire (check valve internal and piston), UHMWPE (seals), PTFE (check valves).

1.1.4 Long Term Pressure Calibration Accuracy

The electronic pressure transducer has been zeroed and calibrated at the factory. Over the life of the pump, some drift may occur.

If pressure calibration and/or drift is a concern, consult the factory.

1.1.5 Self-Flushing Pump Head

Self-flushing pump heads provide continuous washing of the piston surface without the inconvenience of a manual flush or gravity feed arrangement. The self-flushing pump head uses a self-flush seal and secondary set of check valves to create a continuous and positive flow in the area behind the high-pressure pump seal. The flushing solution washes away any buffer salts that have precipitated onto the piston. If not removed, these precipitates can abrade the high-pressure seal and cause premature seal failure, leakage, and can possibly damage the pump.

1.1.6 Recommended Use of Self-Flush Feature

It is recommended that the Self-Flush feature be used to improve seal life in a number of applications. In particular, (as stated above) if pumping buffers, acids/bases, or any inorganic solution near saturation, the pump should utilize the Self-Flush feature. With every piston stroke, an extremely thin film of solution is pulled back past the seal. If this zone is dry (without use of Self-Flush) then crystals will form with continuous operation, which will ultimately damage the seal.

Another application where Self-Flush is highly recommended is when pumping Tetrahydrofuran (a.k.a. THF, Diethylene Oxide) or other volatile solvents such as acetone. Volatile solvents will dry rapidly behind the seal (without the use of Self Flush), which will dry and degrade the seal.

IPA, Methanol, 20% IPA/water mix or 20% Methanol/water mix are good choices for the flush solution. Consult the factory for specific recommendations.

Refer to Figure 1-1, for a detailed drawing of a self-flushing pump head.

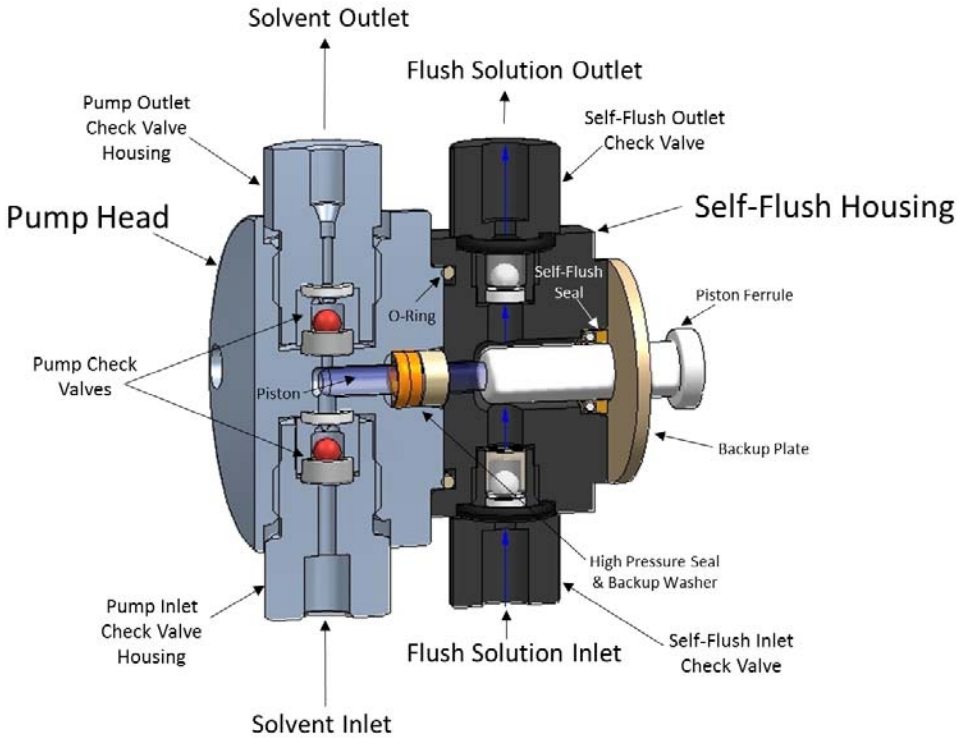

Figure 1-1 ReaXus self-flushing pump head

Note

Figure 1-1 may not represent exactly what is installed in the purchased pump.

1.1.7 Pump Modification When Self-Flush is Not Used

If the self-flush feature is not used, it is strongly recommended to carefully remove the self-flush seal with the seal tool provided, and replace with the provided guide bushing (Figure 1-2). If this is not done, low flow rates, excessive noise and shortened pump life will result.

It is also a good practice to remove the inlet and outlet self-flush check valves and install a plug at the top of the self-flush housing, leaving the bottom of the self-flush housing open. Doing this allows for easy visual notification if there is a leak in the high pressure pump seal.

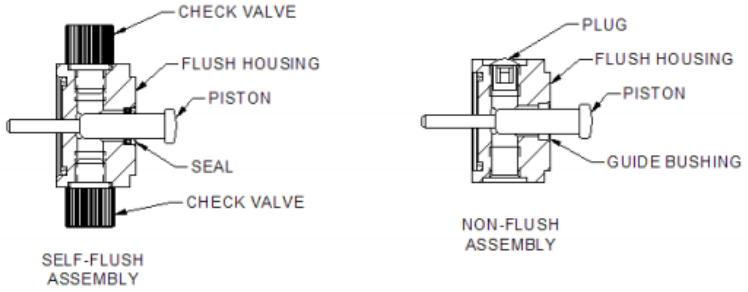

Figure 1-2 Self-flush and non-flush assemblies

ReaXus Reciprocating Pump

Section 2 Quick Start Guide

2.1 Quick Start-Up

⚠ CAUTION

Always release pressure from the pump slowly. A rapid pressure release could cause the pulse dampener diaphragm to rupture. Please refer Section 3.2.5 *Priming the Pump and the Flushing Lines* for more information.

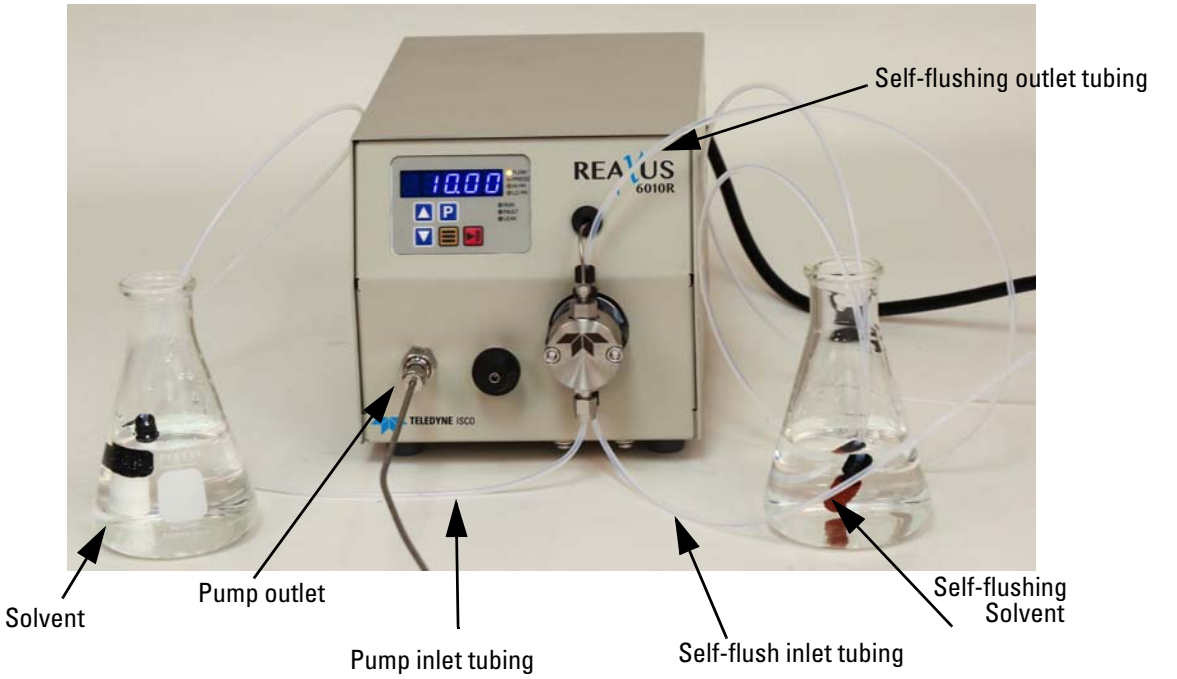

Figure 2-1 Starting the pump

Self-Flush

1. Connect self-flush solution inlet and outlet tubing as shown.
2. Attach syringe to outlet self-flush tubing.
3. Draw syringe back to prime.
4. After solvent has been pulled through the tubing into the syringe, remove syringe and place tubing in solvent.

☑ Note

Replace self-flush solution weekly.

Pump

1. Connect pump inlet tubing (Figure 2-2).

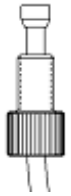

Figure 2-2 Ferrule; in the correct position

2. Make sure ferrule is in the correct position and attach syringe to Prime / Purge.
3. Open PRIME / Purge valve by turning knob counterclockwise one to two turns.
4. Draw syringe back to prime and draw approximately 20 mL of fluid.
5. Press PRIME button (P), continue to draw on syringe until no bubbles are seen.
6. Close PRIME / Purge valve.
7. Press PRIME button (P).
8. Remove syringe.

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Section 3 Installation

3.1 Installation

The following contains information on unpacking and installing the ReaXus Pump.

3.1.1 Unpacking and Inspection

Prior to opening the shipping container, inspect it for damage or evidence of mishandling. If it has been damaged or mishandled, notify the carrier before opening the container. Once the container is opened, inspect the contents for damage. Any damage should be reported to the carrier immediately. Save the shipping container.Check the contents against the packing list.

3.1.2 Location/Environment

The instrument must be located on a stable flat surface with at least a four inch clearance on all sides for proper ventilation and the necessary electrical and fluid connections. The acceptable environment for the ReaXus pump is normal indoor laboratory conditions and must adhere to pollution degree 2. The installation altitude shall not exceed 2,000 meters. The area must be clean and have a stable temperature and humidity. The specific temperature and humidity conditions are 10 to 40 °C and 20% to 90% relative humidity.

3.1.3 Electrical Connections

Using the power cord supplied with the pump, or equivalent, plug the pump into a properly grounded electrical outlet. Acceptable input power is 100 – 240 VAC, 50/60 Hz. Voltage fluctuations must not exceed ±10% of the nominal supply voltage.

⚠ WARNING

Do not bypass the safety ground connection as a serious shock hazard could result.

3.1.4 Solvent Preparation

Proper solvent preparation will prevent a great number of pumping problems. The most common problem is bubble formation, which may affect the flow rate consistency. Aside from leaky fittings, the problem of bubble formation arises from two sources: solvent out-gassing and cavitation. Filtration of solvents is also required.

Solvent Out-gassing and Sparging

Solvent out-gassing occurs because the mobile phase contains dissolved atmospheric gases, primarily N2 and O2. These dissolved gases may lead to bubble formation and should be removed by degassing the mobile phase before or during use. The best practical technique for degassing is to sparge the solvent with standard laboratory grade (99.9+%) helium. Helium is only sparingly soluble in solvents, so other gases dissolved in the

solvent diffuse into the helium bubbles and are swept from the system. Solvent filtration is not an effective alternative to helium degassing.

It is recommended to sparge the solvent vigorously for 10 to 15 minutes before using it. Then maintain a trickle sparge during use to keep atmospheric gases from dissolving back into the mobile phase. The sparged solvent must be continually blanketed with helium at 2 to 3 psi. Non- blanketed, sparged solvents will allow atmospheric gases to dissolve back into the mobile phase within four hours.

Solvent mixtures using water and organic solvents (like methanol or acetonitrile) hold less dissolved gas than pure solvents. Sparging to reduce the amount of dissolved gas is therefore particularly important when utilizing solvent mixture.

Even with sparging, some out-gassing may occur. A back pressure regulator installed after the detector flow cell will help prevent bubbles from forming and thus limit baseline noise.

Cavitation

Cavitation occurs when inlet conditions restrict the flow of solvent and vapor bubbles are formed during the inlet stroke. The key to preventing cavitation is to reduce inlet restrictions. The most common causes of inlet restrictions are crimped inlet lines and plugged inlet filters. Inlet lines with tubing longer than 48" (120 cm) or with tubing of less than 0.085" (2 mm) ID may also cause cavitation.

Placing the solvent reservoirs below the pump level also promotes cavitation. The optimal location of the reservoirs is slightly above the pump level, but it is adequate to have them on the same level as the pump.

Filtration

Solvent filtration is good practice for the reliability of the ReaXus pump and other components in the system. Solvents should always be filtered with a 0.5 micron filter prior to use. This ensures that no particles will interfere with the reliable operation of the piston seals and check valves. Solvents in which buffers or other salts readily precipitate out will need to be filtered more often. After filtration, the solvents should be stored in a closed, particulate-free bottle.

⚠ CAUTION

Solvents with Harmful Effects

All portions of the ReaXus pump that contact mobile phase are manufactured of type 316 stainless steel, ceramic, sapphire, ruby, or fluoropolymers. Some of these materials are extremely sensitive to acids (including some Lewis acids) and acid halides. Avoid using solvents that contain any amount of hydrochloric acid.

Some of the solvents to specifically avoid are:

- Aqua Regia
- Bromine
- Chlorine Anhydrous
- Copper Chloride
- Ferric Chloride
- Ferrous Chloride
- Freon 12 (wet)
- Hydrobromic Acid
- Hydrochloric Acid
- Hydrofluoric Acid
- Hydrofluorsilicic Acid
- Hydrogen Peroxide
- Iodine
- Mercuric Chloride
- Guanidine

In addition, some users have observed that chloroform and carbon tetrachloride slowly decompose to liberate hydrochloric acid, which, as noted above, attacks stainless steel. Do not leave these solvents in the systems for a prolonged period.

It is also recommended to avoid ammonium hydroxide. Although ammonium hydroxide will not harm the pump itself, it is likely to damage the stator and rotor in injection valves.

3.2 Instrument Installation

3.2.1 Mobile Phase Reservoirs

The mobile phase reservoir should be placed at the same level or slightly higher than the pump, never below the pump, and the inlet tubing should be as short as practical. These steps minimize pressure losses on the inlet side of the pump during refill and help to avoid bubble formation. These steps are particularly important when using high vapor pressure solvents (hexane, methylene chloride, etc.). Mobile phases should be degassed, filtered and covered.

3.2.2 Self-Flush Solution

If the self-flush feature is being used, self-flush heads require 250-500 mL of 20% isopropanol in water as a flushing solution. This flush solution should be replaced with a fresh solution weekly to avoid frequent pump maintenance.

Alternate wash solutions may be used depending on the liquids used for the application. Contact the manufacturer for specific recommendations.

3.2.3 Inlet Tubing and Filters

Inlet tubing is supplied with the pump startup kit, has a 0.085” ID, a 1/8” OD, and is made of a Teflon-based material. Use a 20 micron slip-on inlet filter.

3.2.4 Outlet Tubing

Outlet tubing (not supplied with the pump) should be compatible with the supplied outlet fittings. The tubing must be cut squarely and with no burrs. The tube itself should not be crimped and the center hole must be open. A tubing cutter is recommended for cutting stainless steel tubing.

3.2.5 Priming the Pump and the Flushing Lines

1. Be sure all of the connections downstream of the prime/purge valve are closed.
2. Connect a syringe to the priming valve.
3. Open the prime/purge valve 1 to 2 turns (counter-clockwise). Prime the pump by pulling mobile phase and any air bubbles through the system and into the syringe (a minimum of 20 mL).
4. Press the Prime button and continue to draw on the syringe until no bubbles are seen.
5. Close the prime/purge valve.
6. Press the Prime button and remove the syringe.

Be sure to replace solvent weekly.

⚠ CAUTION

Always release pressure from the pump slowly. A rapid pressure release could cause the pulse damper diaphragm to rupture.

The pulse damper diaphragm can be damaged by over-pressurization (above 6,000 psi), or due to rapid decompression of the damper from high pressure to atmospheric pressure. The system pressure must be allowed to bleed down slowly to <500 psi before opening the fluid path to atmosphere. Typical bleed down parameters are ~3 seconds from 6,000 psi, or ~2 seconds from 4,000 psi.

To prime the flush lines for a self-flush head:

1. Place the inlet line in the flush solution and connect a syringe to the outlet line and apply suction until the line is filled with flush solution.
2. Place the outlet line in the flush solution. Secure both flush lines in the flush solution container so they stay immersed during pump operation.

Be sure to replace the self-flush solution weekly.

Please refer to the Quick Startup Guide (Section 2) for more information.

3.3 Preparation for Storage or Shipping

3.3.1 Isopropanol Flush

1. Disconnect the outlet tubing from the pump.
2. Place the inlet filter in isopropanol.
3. Use a syringe to draw a minimum of 50 ml through the pump.
4. Pump a minimum of 5 ml of isopropanol to exit.
5. Leave the inlet tubing connected to the pump.
6. Place the inlet filter in a small plastic bag and attach it to the tubing with a rubber band.
7. Plug the outlet port with the shipping plug or leave a length of outlet tubing on the pump or cover the outlet port with plastic film.

3.3.2 Packaging for Shipping

Reship in the original carton, if possible. If the original carton is not available, wrap the pump in several layers of bubble wrap and cushion the bottom, top, and all four sides with 2" of packaging foam.

Although heavy, this pump is a delicate instrument and must be carefully packaged to withstand the shocks and vibration of shipment.

ReaXus Reciprocating Pump

Section 4 Operation

4.1 Front Panel and Display Indicators

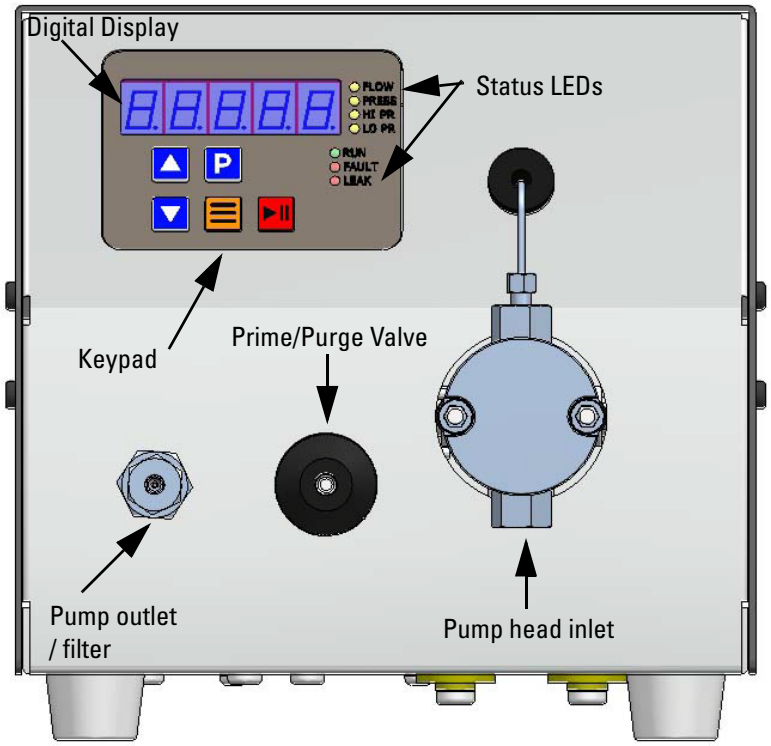

Figure 4-1 Front panel components

Prime / Purge Valve

⚠ CAUTION

When the PRIME button (P) is pressed, the pump will run at the maximum flow rate. Be sure the prime/purge valve is open.

The prime/purge valve vents the flow to atmosphere and permits efficient priming of the ReaXus pump. When the valve is closed (fully clock-wise), high-pressure flow is directed to the Filter/Outlet port. When the valve is opened (counter clock-wise), pressure is vented and flow exits through the drain port in the prime/purge valve stem assembly. Suction with a Luer tip syringe at the drain port will purge air bubbles from the pump and reservoir lines (provided there are no open valves to lines down-stream at the injector/column interface). To prime the pump, draw about 20 to 30 mL of mobile phase.

Filter/Outlet

A high-pressure in-line filter (0.5 micron rating) is included at the output of the ReaXus pump. The Filter/Outlet port is the high pressure filter closure and is designed for a 1/16" OD tubing connection.

Digital Display

The 5-digit display shows the pump flow rate (mL/min), system pressure (psi, bar, or MPa), or the set upper or lower pressure limit (psi, bar, or MPa) when operating. Choice of display is selected with the MODE key.

Keypad

	RUN/STOP button - alternately starts and stops the pump.
	UP-ARROW button - increases the displayed parameter.
	DOWN-ARROW button - decreases the displayed parameter.
	PRIME button – the pump will run at its maximum flow rate. To exit prime mode, either press the PRIME button again, or press the RUN/STOP button
	MODE button - cycles through the four display modes: flow rate, pressure, upper pressure limit, or lower pressure limit. A status LED to the right of the digital display indicates which mode is active. NOTE: If the pump does not have pressure monitoring, this button will be disabled.

Fast and Slow Button Repeat

If the UP-ARROW or DOWN-ARROW button is held down for more than approximately one half of a second, the button press will repeat at a slow rate. Once slow button repeat has begun, fast button repeat can be initiated by using a second finger to press down the second arrow button. Switching back and forth between repeat speeds can be accomplished by pressing and releasing the second arrow button while keeping the first arrow button held down.

Status LEDs

- FLOW: When lit, the display shows flow rate in mL/min.
- PRESS: When lit, the display shows system pressure in psi, bar, or MPa
- HI PR: When lit, the display shows the user-set upper pressure limit in psi, bar, or MPa
- LO PR: When lit, the display shows the user-set lower pressure limit in psi, bar, or MPa
- RUN: Lights to indicate that the pump is running.
- FAULT: Lights when a pressure or leak fault occurs.

4.1.1 Menu Screens

Pressure Readout

Displays the current system pressure in psi, as read by a pressure sensor within the pump cabinet.

Upper Pressure Limit

Displays the upper pressure limit for the pump. This value may be adjusted by using the up and down arrow keys, or the appropriate serial commands. When the system pressure exceeds the upper pressure limit, an upper pressure fault will be triggered, and the pump will stop. In some cases, there may be a small amount of headroom between the upper pressure limit and the system pressure which actually triggers the fault, which may cause the fault to appear to be delayed. In these cases, it may be advantageous to set the limit to a slightly lower value.

Lower Pressure Limit

Displays the lower pressure limit for the pump. This value may be adjusted by using the up and down arrow keys, or the appropriate serial commands. When the system pressure is below the lower pressure limit, a lower pressure fault will be triggered, and the pump will stop. There is a delay between the start of the pump and the monitoring of the pressure for the low pressure fault. This delay is typically 20 pump strokes.

4.1.2 Power-Up Configuration

On power-up, press and hold the MODE button to access the PUMP SETUP MENU. The LED display will briefly show "SETUP," and then enter the pump setup menu.

Each setup parameter includes a TITLE screen followed by a VALUE screen. Within the pump setup menu, use the MODE button to cycle forward through the menu screens; use the PRIME button to cycle in reverse.

While a changeable value is displayed, use the UP and DOWN ARROW buttons to modify the value. Depending on the pump model, certain values may not be changeable.

To exit the pump setup menu and save all changes, press the RUN/STOP button. Note that changes will NOT be saved until the RUN/STOP button is pressed; exiting the pump setup menu by turning the instrument power off will discard all changes.

Firmware Identification

The first setup parameter displayed is the instrument firmware identification, denoted by the title screen "F-Id". Press the MODE button to advance the menu screen to display the firmware version number.

Firmware Version

The next setup parameter displayed is the instrument firmware version, denoted by the title screen "Ver". Press the MODE button to advance the menu screen to display the firmware version.

Flow Compensation:

The next setup parameter displayed is the flow rate compensation, denoted by the title screen "Cal". Press the MODE button to advance the menu screen to display the flow rate compensation value, a number between 85.0 and 115.0 which represents the amount of compensation affecting the running speed of the pump, in percentage. The nominal value is 100.0, and indicates that the pump is running at 100.0% of the intended speed, meaning there is no secondary adjustment. A value of 98.7 means the pump is running 1.3% slower than nominal; a value of 106.4 means the pumps is running 6.4% faster than nominal.

Motor Stall Detector

The next setup parameter displayed is the motor stall detector, denoted by the title screen "Stall". Press the MODE button to advance the menu screen to display the motor stall detector state, either on (enabled) or off (disabled). While enabled, the motor stall detector creates a motor stall fault when the motor rotation is not properly detected.

Solvent Select

The next setup parameter displayed is the Solvent Select feature, denoted by the title screen "S-Sel". Press the MODE button to advance the menu screen to display the currently selected solvent, or OFF if this feature is disabled. Solvent Select allows the pump to produce accurate flow rates for various solvents.

Leak Detector

The next setup parameter displayed is the leak detector, denoted by the title screen "Drip". Press the MODE button to advance the menu screen to display the leak detector state, either on (enabled) or off (disabled). While enabled, the leak detector creates a leak warning (default) or leak fault (configurable with LM2 command) when a leak is detected.

Analog Input Mode

The next setup parameter displayed is the analog input mode, denoted by the title screen "Input". Press the MODE button to advance the menu screen to display the currently selected analog input mode, either voltage (0-10Vdc) or current (4-20mA). Refer to Appendix A for additional details.

Analog Input Enable / Override:

The next setup parameter displayed is the analog input enable/override, denoted by the title screen "An-En". Press the MODE button to advance the menu screen to display the analog input enable/override state, either on (enabled) or off (disabled). While enabled, the analog input enable/override allows the analog input to be used without the need to wire the enable line on the external control connector. Refer to Appendix A for additional details.

Constant Pressure PID Setup

The next 3 setup parameters displayed are the PID parameters used by Constant Pressure pumps, denoted by the title screens "PID-P", "PID-I", and "PID-D". For Constant Flow pumps, the value screens will display off.

Serial Baud Rate

The next setup parameter displayed is the serial baud rate, denoted by the title screen "Baud". Press the MODE button to advance the menu screen to display the current baud rate, either

9600 or 19200. Note that the RUN/STOP button must be used to exit the pump setup menu and save all changes; changes made to the baud rate will then become effective on the next power cycle.

Pressure Smoothing Filter

The next setup parameter displayed is the pressure smoothing filter, denoted by the title screen "P-Avg". Press the MODE button to advance the menu screen to display the pressure smoothing filter value, a number between 0 and 16 which represents how much smoothing is applied to the pressure signal. Higher values denote increased smoothing.

Non-volatile Memory Reset

On power-up, press and hold the UP ARROW button perform an instrument reset. The LED display will briefly show "reset", and then enter the normal pump operating menu. A rest restores the instrument to its original factory settings. A reset

automatically occurs when the firmware is updated.

4.2 Rear Panel Remote Input

Micro USB and RS-232C ports are provided on the back panel (Figure 3). A computer with appropriate software can be used to control the pump operation remotely via these connections.

See Appendix for details on connection and operation.

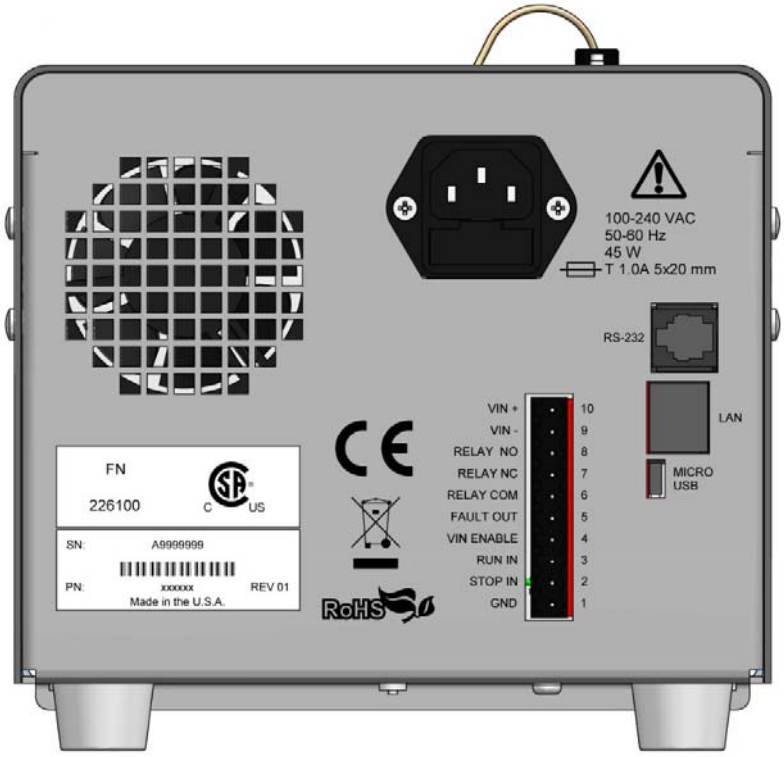

Figure 4-2 Rear panel

⚠ WARNING

To avoid electric shock, do not remove the pump's protective cover. To avoid nonlethal electric shock when

the pump is in operation, avoid touching the areas marked with the high voltage warning symbol. Remove the power cord and turn the pump off before touching these areas.

ReaXus Reciprocating Pump

Section 5 Maintenance

> **Note**
>
> Cleaning and minor repairs of the ReaXus Pump can be performed as outlined below.

5.1 Filter Replacement

Inlet Filter

Figure 5-1 Inlet filter

Inlet filters should be checked periodically to ensure that they are clean and not restricting flow. A restriction could cause cavitation and flow loss in the pump. Two problems that can plug an inlet filter are microbial growth and impure solvents. To prevent microbial growth, use at least 10-20% organic solvent in the mobile phase or add a growth-inhibiting compound. If 100% water or an aqueous solution is pumped without any inhibitors, microbes will grow in the inlet filter over time, even if fresh solution is made every day. Always use well filtered solvents for the mobile phase.

Outlet Filter

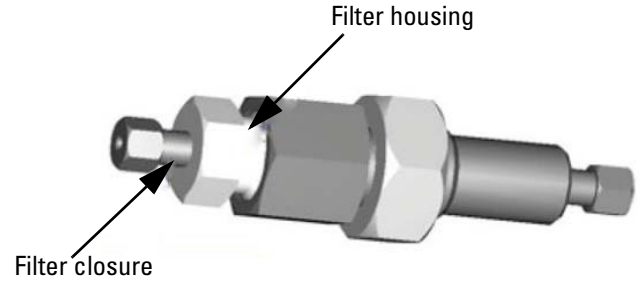

Figure 5-2 Outlet Filter

To service the outlet filter on stainless steel pumps:

1. Unscrew the filter enclosure from the filter housing.

2. Use a seal insertion/removal tool or a non-metallic object (such as a wooden toothpick) to remove the large seal that remains in the housing.

⚠ CAUTION

Do not use a metal object such as a screwdriver or paperclip to remove the seal. Doing so can scratch the precision surface of the seat and may cause the filter to leak.

3. Unscrew the old filter and remove the small seal from the filter closure.
4. Place one of the small seals included in the replacement element kit over one of the new filters from the kit. Screw the new filter into the filter closure (finger tight).
5. Place one of the large seals from the replacement kit on the filter closure. Insert the filter closure into the housing and tighten ¼ turn after seating.

5.2 Pump Head Assemblies

⚠ CAUTION

When working with aggressive or toxic solvents, residual amounts of these chemicals could be present in the system.

5.2.1 Removing the Pump Head Assembly

The standard Stainless Steel pump head assemblies are shown below in *Figures 6, 7, 8, and 9*. Notice that there is a guide bushing used in the place of the self-flush seal when the self-flush is not being used.

To remove the pump head:

1. Turn OFF the pump power.
2. Unplug the power cord.
3. Remove the inlet line and filter from the mobile phase reservoir. Be careful not to damage the inlet filter or crimp the PTFE tubing.
4. Remove the inlet line from the inlet check valve.
5. Remove the outlet line from the outlet check valve.
6. Remove the inlet and outlet self-flush lines.
7. Carefully remove the two Allen nuts at the front of the pump head with a 3/16 allen wrench.

⚠ CAUTION

Be careful not to break the piston when removing the pump head. Twisting the pump head can cause the piston to break.

8. Carefully separate the pump head from the pump.

a. Move the pump head straight out from the pump and remove it from the piston. **Be careful not to break or damage the piston.**

b. Remove the seal and seal backup washer from the piston if they did not stay in the pump head.

c. Remove the O-ring.

9. Carefully separate the self-flush housing from the pump. Move the flush housing straight out from the pump and remove it from the piston. Also remove the self-flush seal or guide bushing from the piston if it did not stay in the flush housing.

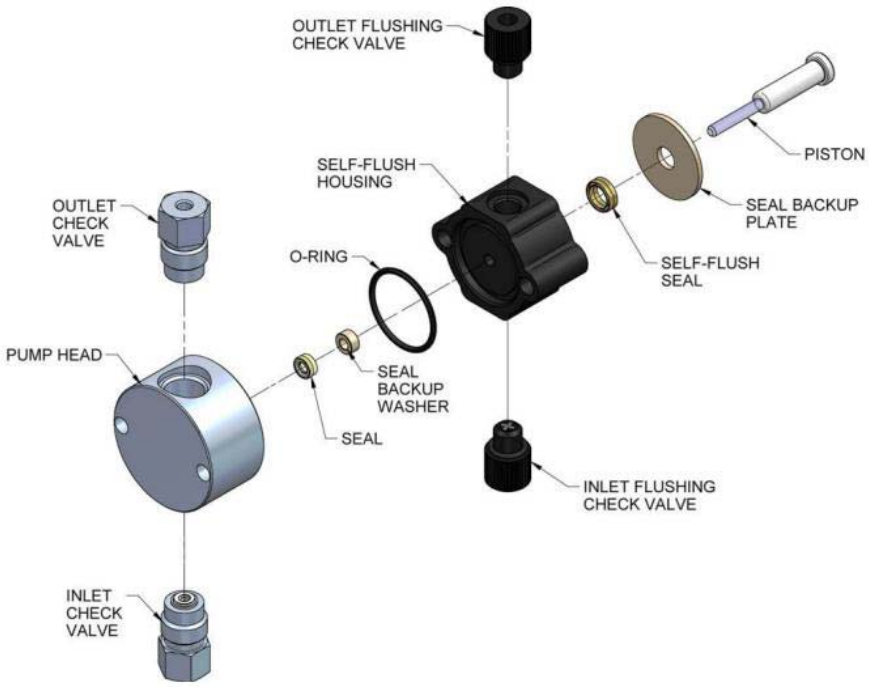

Figure 5-3 Stainless steel self-flushing pump head assembly

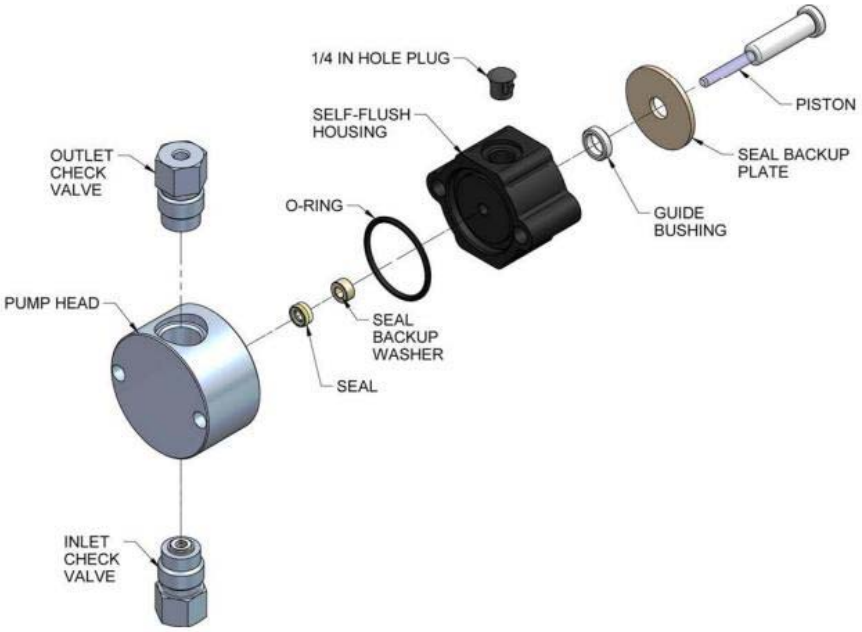

Figure 5-4 Stainless steel non-self-flushing pump head assembly

5.2.2 Cleaning the Pump Head Assembly

If the piston seal or self-flush seal are going to be removed, it is recommended to have a new set on hand to install after cleaning. It is not recommended to reinstall the used piston seal or self-flush seal since they are likely to be scratched and damaged during removal and would not provide a reliable seal if reused. If the seal is removed, use only the flanged end of the plastic seal removal tool supplied with the seal replacement kit. Avoid scratching the sealing surface in the pump head.

Inspect the piston seal cavity in the pump head. Remove any foreign material using a cotton swab or equivalent, and avoid scratching the sealing surfaces. Be sure no fibers from the cleaning swab remain in the components.

The pump head, check valves, and flushing housing may be further cleaned using a laboratory grade detergent solution in an ultrasonic bath for at least 30 minutes, followed by rinsing for at least 10 minutes in distilled water. Be sure that all particles loosened by the above procedures have been removed from the components before reassembly.

5.2.3 Replacing the Pump Head

1. Carefully align the flush housing and gently slide it into place on the pump. Make sure that the Inlet self-flush check valve is on the bottom and the Outlet self-flush check valve is on the top. If misalignment with the piston occurs, gently realign the piston holder.
2. Install the O-ring in its grove.

3. Line up the pump head and carefully slide it into place. Be sure that the Inlet valve is on the bottom and the Outlet valve is on the top. Do not force the pump head into place.
4. Finger tighten the allen nuts into place. To tighten firmly, alternately turn nuts 1/4 turn with a suitable tool (alternating side-to-side) while gently rotating the pump head to center it.
5. Torque the Allen nuts to 30 in-lbs using a suitable torque wrench and 3/16 allen wrench adaptor.
6. Reattach the inlet and outlet lines. Reattach the self-flush lines. Change the flushing solution.

5.3 Piston Seals

Lower than normal pressure, pressure variations, and leaks in the pumping system can all indicate possible problems with the piston seal. Depending on the fluid or mobile phase used, piston seal replacement is often necessary after 1000 hours of running time.

5.3.1 Removing the Seals

1. Remove the pump head and self-flush assemblies as described above.
2. Remove the backup washer if it is present in the pump head.
3. Insert the flanged end of the seal insertion/removal tool into the seal cavity on the pump head. Tilt it slightly so that flange is under the seal and pull out the seal.

⚠ CAUTION

Using any other “tool” will scratch the finish of the sealing surface and create a leak.

4. Repeat the procedure for the low-pressure seal in the flush housing.
5. Inspect, and if necessary, clean the pump head as described in Section 5.2.2.

5.3.2 Replacing the Seals

1. Place a **high pressure replacement seal** (*Figure* .) on the rod-shaped end of the seal insertion/removal tool so that the energizer is visible when the seal is fully seated on the tool. Insert the seal into the pump head.. Be careful to line up the seal with the cavity while inserting. Then, withdraw the tool, leaving the seal in the pump head. When looking into the pump head cavity, only the polymer side of the seal should be visible.

Figure 5-5 Example of polymer side vs. energized side of seal

2. Place a **self-flush replacement seal** on the seal insertion/removal tool so that the energizer in the seal is visible when the seal is on the tool. As in the previous step, insert the tool and seal into the seal cavity on the flushing housing, taking care to line up the seal with the cavity, and then withdraw the tool. When the seal is fully inserted, only the polymer side of the seal will be visible in the seal cavity.

> ☑ ***Note***
>
> If the self-flush feature is not being used, install the provided guide bushing in the place of the self-flush seal.

3. Place the seal back-up washer over the high-pressure seal in the pump head.
4. Replace the self-flush and pump head assemblies.
5. Condition the new seals as described below.

5.3.3 Conditioning New Seals

New seals should be conditioned prior to use. Conditioning is the process of running the seals wet under controlled conditions to allow surfaces to seat and to prepare the seal for operation.

> ☑ ***Note***
>
> Use only organic solvents to condition new seals. Buffer solutions and salt solutions should never be used to condition new seals. Recommended solvents are HPLC-grade methanol and isopropanol, and water mixtures of either.

Suggested Conditioning Parameters

Using a restrictor coil or a suitable column, run the pump with a 50:50 solution of isopropanol (or methanol) and water for 30 minutes at the back pressure and flow rate listed under Phase1 (Table 5-1), depending on the pump head type.

Then, run the pump for 15 minutes at a back pressure and flow rate listed under Phase 2 (Table 5-1), depending on the pump head type.

Table 5-1 Phase 1 & 2		
Phase 1		
Pump Type	**Pressure**	**Floe Rate**
10 mL/min pump	2,000 psi	<3 mL/min
Phase 2		
Pump Type	**Pressure**	**Flow Rate**
10 mL/min pump	3,000 – 4,000 psi	3 - 4 mL/min

5.4 Pistons

5.4.1 Cleaning the Piston

1. After the pump head and self-flush housing are removed, gently remove the backup seal plate from the pump housing, using either a small screwdriver or toothpick in the slot on top of the pump housing.
2. Grasp the metal base of the piston assembly to avoid exerting any side load on the sapphire rod, and remove the piston from the slot in the carrier by sliding it up.
3. Use the scouring pad included in the seal replacement kit to clean the piston. Gently squeeze the piston within a folded section of the pad and rub the pad along the length of the piston. Rotate the pad frequently to assure the entire surface is scrubbed. Do not exert pressure perpendicular to the length of the piston, as this may cause the piston to break. After scouring, use a lint-free cloth, dampened with alcohol, to wipe the piston clean.
4. To reinstall the piston, grasp the metal base of the piston assembly and insert it into the slot in the piston carrier until it bottoms in the slot.

5.4.2 Replacing the Piston

Remove the pump head and self-flush assemblies.

1. Grasp the metal base of the piston assembly to avoid exerting any side load on the sapphire rod, and remove the piston from the slot in the carrier by sliding it up.
2. Grasp the metal base of the replacement piston assembly, and insert it into the slot in the piston carrier until it bottoms in the slot.
3. Replace the pump head as described below.

5.5 Check Valve Cleaning and Replacement

Many check valve problems are the result of small particles interfering with the operation of the check valve. As a result, simply cleaning the pump head with the appropriate laboratory apparatus may resolve any issues.

5.5.1 Check Valve Cleaning

1. To clean pump check valves, remove the pump head and immerse the entire head into a laboratory ultrasonic cleaner.

2. Sonicate for about 30 minutes using a standard cleaning solution. Rinse the pump head thoroughly with distilled water.
3. Replace the pump head assembly.
4. Run the pump at 1 mL/min with distilled water for fifteen minutes. Always direct the output directly to a waste beaker during cleaning (do not recycle).

If this procedure does not return the pump to proper performance, the check valves should be replaced. See Figure 5-6 for an example of new check valves from their package.

5.5.2 Check Valve Replacement

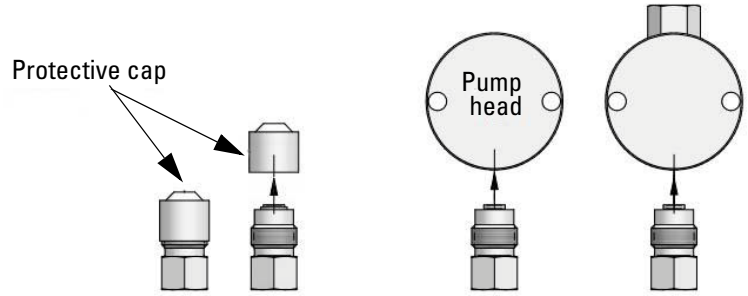

Figure 5-6 New check valves from package in proper orientation

1. Remove the pump head assembly.
2. Remove the check valve housings, capsules and seals (Stainless Steel only) from the pump head, being careful not to scratch the sealing surfaces in the pump head. If necessary, use a seal removal tool to remove the capsules and/or capsule seals from the pump head.

⚠ CAUTION

Be careful not to break the piston when removing the pump head. Twisting the pump head can cause the piston to break.

Make sure check valve is kept in the above position to avoid losing parts.

☑ *Note*

The size of the through-holes in the pump head. If one is larger, then this side attaches to the Inlet check valve assembly. If the through-holes are the same size, then the orientation does not matter.

3. Hold one new check valve assembly as shown in *Figure* 5-6 and unscrew the protective cap. With the check valve assembly maintained in the above position, thread it into the proper pump head port until it is snug Install the other check valve assembly similarly.

☑ Note

It may be easier to install the Outlet check valve first (if the hole sizes are different), from below; then turn the pump head upside down and install the Inlet check valve.

4. Reinstall the pump head assembly.
5. Tighten the check valve housings on Stainless Steel pumps to 75 inch-lbs, or enough to seal at maximum pressure.
6. Reattach the solvent inlet and outlet lines.
7. Reconnect the self-flush lines to the self-flush check valves.

5.5.3 Self-Flushing Check Valves

Self-flush check valves can be replaced without removing the pump head of self-flush assembly, and do not require any tools. When installing new check valves, notice the outlet has a transparent washer, and the Inlet has a cross ball retainer. Also, the words INLET and OUTLET should be visible on the top of the self-flush check valves.

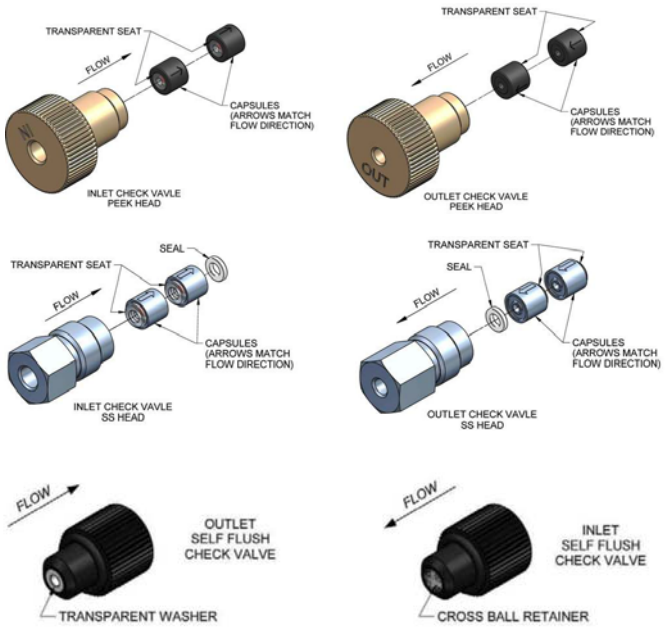

Figure 5-7 Check valve assemblies for Stainless Steel and Self-flushing housing

☑ Note

The Sapphire Seat is an opaque white ring. The red ruby ball can be seen through the ring. Flow is always away from the sapphire seat, as shown by the directional arrows etched on the capsules.

The Stainless Steel capsules also include one removable PTFE seal (as shown in *Figure* 5-7 above).

The **INLET** check valve has a **LARGER** opening (1/4"-28, flat bottom seat) for the 1/8" inlet tubing; the **OUTLET** check valve has a **SMALLER** opening (#10-32, cone seat) for the 1/16" outlet tubing.

5.6 Pulse Damper Replacement

5.6.1 Removing the Pulse Damper

1. Make certain that the system has been depressurized. Unplug the power cord and remove the cover.
2. Disconnect the tubing from the pulse damper.
3. Disconnect the transducer from the circuit board.
4. Remove the screws that secure the pulse damper from the underside of the pump.
5. Remove the pulse damper.

5.6.2 Pulse Damper Refurbishing

Refurbishing the pulse damper is a time-consuming procedure. It is recommended to return the pulse damper to have it rebuilt. Do not attempt to refill or refurbish the pulse damper without a refurbishing kit. Instructions are furnished with the kit.

5.6.3 Pulse Damper Installation

1. Position the pulse damper, aligning it with the mounting holes in the bottom of the cabinet. The pressure transducer should be pointed toward the rear of the cabinet.
2. From the underside of the pump cabinet, tighten the screws to hold the pulse damper in place.
3. Connect the pump outlet tubing to the port at the rear of the pulse damper (i.e., toward the rear of the cabinet). With the remaining pulse damper port towards the front of the cabinet, connect the line from the pulse damper to the bulkhead outlet filter.
4. Connect the transducer's wire harness connector to pressure board connector P1.
5. Replace the pump cover.

5.6.4 Cleaning the Pump

1. Prepare the following solvents, utilizing the solvent preparation methods detailed in the above section:
   a. 100% isopropanol
   b. 100% filtered, distilled water
   c. 20% nitric acid/water solution (only prepare if the flow path is stainless steel)
2. Direct the pump outlet line to a waste beaker.
3. Press the PRIME (P) button to set the pump flow rate to maximum.

4. Pump 100% isopropanol through the pump for 3 minutes.
5. Pump 100% filtered, distilled water through the pump for 3 minutes.

For stainless steel flow paths, proceed to Step 6.

⚠ WARNING

Use standard laboratory procedures and extreme care when handling strong acids and bases.

6. Pump a 20% nitric acid/water solution through the pump for 3 minutes.
7. Flush the pump with 100% filtered, distilled water for at least 3 minutes.
8. Pump 100% isopropanol through the pump for 3 minutes.

The pump is now prepared for any mobile phase or short- or long-term shutdown.

5.6.5 Lubrication

The ReaXus pump has modest lubrication requirements. The bearings in the pump housing and piston carrier are permanently lubricated and require no maintenance. A small dab of a light grease such as Lubriplate 630-AA on the cam is the only recommended lubrication. Be sure not to get lubricant on the body of the piston carrier, as this can retard its movement and interfere with proper pumping. Keeping the interior of the pump free of dirt and dust will extend the pump's useful life.

5.6.6 Fuse Replacement

Two fuses are located in the power entry module at the rear of the cabinet.

Troubleshooting the fuses is straightforward. If the power cord is plugged in and the on/off power switch is on and the fan does not run, check the two fuses in the power entry module. To gain access to these fuses, gently pry off the cover plate with a small flat-bladed screwdriver (Figure 5-8).

Replace with 1 amp fuses, 5x20mm, Slo-Blo (time-lag), 250V.

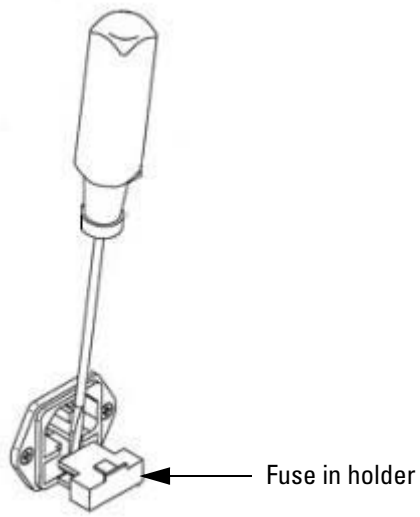

Figure 5-8 Fuse replacement

ReaXus Reciprocating Pump

Appendix A Replacement Parts List

A.1 How to Order

Parts and equipment can be purchased by contacting Teledyne Isco's Customer Service Department.

Teledyne Isco
Customer Service Dept.
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.2 List of Pumps

ReaXus Reciprocating Pump 69-2253-332
ReaXus Reciprocating Pump w/ Jacketed Head. 69-2253-333
ReaXus Reciprocating Pump w/ Jacketed Head. 69-2253-335
ReaXus Reciprocating Pump- Hastelloy 69-2253-336
ReaXus Reciprocating Pump- Hastelloy /w Jacketed Head. 69-2253-337

A.3 List of Kits and Parts

Seal Kit Standard 250000148
Seal (10 Pack). 250000134
Seal Kit Organic. 250000135
Seal Kit (10 Pack, Organic) 250000136
Check Valve Kit (1/8 Inlet & Outlet 250000137
Piston 250000138
Outlet Filter 250000139
Inlet Filter 250000140
Prime Purge Valve Rebuild Kit. 250000141
Pulse Dampener Rebuild Kit. 250000142
Pulse Dampener Replacement 250000143
Replacement Board Set 250000144
Head Kit 250000145
Jacket Head Kit 250000146
Constant Pressure Software 250000147

ReaXus Reciprocating Pump

Appendix B Troubleshooting

B.1 Troubleshooting

Noticed Issue	This May Mean	Possible Cause	Possible Solution
1.Uneven pressure trace. 2.Pressure drops. 3. No flow out the outlet check valve.	1. Bubble in check valve. 2. Leaks in system. 3. Dirty check valve. 4. Bad check valve.	1. Solvent not properly degassed. 2. Fittings are not tight. 3. Mobile phase not properly filtered. 4. Particles from worn piston seal caught in check valve. 5. Plugged inlet filter.	1. Check to be certain that mobile phase is properly degassed. 2. Check connections for lea ks by tightening fittings. 3.Prime the system directly from the outlet check valve. 4. Clean or replace the check valves. 5. Clean or replace inlet filter.
1. Uneven pressure trace. 2. Pressure drops. 3. Fluid between the pump head and the retainer.	1. Leaks in system. 2. The piston seal or self-flush seal is worn.	1. Fittings not tight. 2. Long usage time since last piston seal / self-flush seal change. 3. Salt deposits on seal or self-flush seal (especially if buffered aqueous mobile phases are used).	1. Check all connections for leaks. 2. Replace piston seal & self-flush seal. 3. Check the piston for salt deposits. Clean as necessary.
Pump makes a loud clanging or slapping noise (intermittent contact with cam).	Piston carrier is catching in piston guide.	1. Cap nut screws on the pump head are loose. 2. Seal(s) are worn. 3. Piston guide is worn.	1. Check cap nut screws on pump head. Tighten if necessary. 2. Replace seals. 3. Replace piston guide and seals.
No power when pump turned ON.	Blown fuses in the power entry module.	1. Power surge. 2. Internal short.	1. Replace only with the appropriate fuses. 2. Contact service technician if problem persists.
Colored dye in mobile phase.	Pulse damper diaphragm has burst.	Sudden pressure drop when purging system.	Replace pulse damper.

Noticed Issue	This May Mean	Possible Cause	Possible Solution
Pump runs for 50 pump strokes, then shuts down.	Lower pressure limit is activating.	1. Mobile phase is not properly filtered. 2. Particles from worn seal trapped in the system (e.g., tubing, filters, injection valve, column inlet).	1. Check to be certain the low pressure limit is set to 0 psi. 2. Only increase the low pressure limit after the pump attains operating pressure. 3. Contact service technician.
1. Pump shuts down after run is called even with no column connected. 2. Pump runs to maximum pressure and shuts down.	Clog in fluid system.	Particulate matter clogging inlet system or head of column. Plugged detector line. Injection valve improperly positioned. Column inlet clogged with dirt accumulation.	Filter mobile phase and sample. Check syringe for a barb(s) breaking septa pieces off into the system. Turn pump off immediately and carefully clean lines and cell. Check injection valve for proper rotation. Clean inlet and/or replace column.
No power when pump turned ON. Fan does not run.	Blown fuses in the power entry module.	1. Power surge. 2. Internal short.	1. Replace only with the appropriate fuses. 2. Contact service technician if problem persists.

ReaXus Reciprocating Pump

Appendix C Communication

C.1 Rear Panel Serial Communications Port

A USB 2.0 Micro-B and an RJ12 6P6C RS-232C port are provided on the back panel. A computer with appropriate software can be used to control the pump operation remotely via these connections. Additional drivers may be required for utilization of the USB port. The proper driver may be downloaded from the Teledyne Isco website: www.isco.com

C.1.1 Hardware Implementation

The RS-232 REMOTE INPUT serial communications port is configured for 9600 baud, 8 data bits, 1 stop bit, and no parity. The connector is a standard RJ12 modular telephone type jack. When looking at the connector on the rear panel of the pump, pin 1 is at the top and pin 6 is at the bottom. The pin-out is:

Pin	Function
1,6	Ground
2	DSR (Handshaking input to pump)
3	RXD (Serial data input to pump)
4	TXD (Serial data output from pump)
5	DTR (Handshaking output from pump)

Special wiring considerations: Use the following chart for interfacing the pump's serial communications port to either a 25-pin or a 9-pin COM port on a PC.

Pump	Signal	IMB (DB25) [a]	IBM (DE9)[b]
1,6	Ground	7	5
2	DSR	20	4
3	RXD	2	3
4	TXD	3	2
5	DTR	6	6

a. Jumper pins 4, 5, and 8 on DB25.

b. Jumper pins 1, 7, and 8 on DE9.

C.1.2 Command Interpreter

The pump's high-level command interpreter receives and responds to command packets. The pump will not send a message except when prompted, and it will send a response to every valid command as described below. The response to an invalid command is "Er/".

Each command is characterized by a unique two-letter command code. Commands are not case sensitive; that is, the command codes "PR" "Pr" "pR" and "pr" are all equivalent. Response strings sent by the pump are terminated by the "/" character.

If the pump's response is "Er/", sending a "#" to clear any characters remaining in the command buffer may be beneficial. The pump will automatically clear all characters in the command buffer after one second elapses from the time at which the last character of an incomplete command was received.

Optionally, a carriage return may be used to indicate the end of a transmitted string. A received carriage return will cause the pump to immediately respond to the received command, and may help speed communications.

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Pump Command List

General Commands			
Command	**Response**	**Description**	**Example**
CC	OK,<pressure>,<flow>/	**Current Conditions:** returns the following values: <pressure>: current operating pressure <flow>: current flow rate in ml/min	OK,0522,12.00/
CF	OK/	**Clear Faults:** clears any active faults.	OK/

General Commands			
Command	**Response**	**Description**	**Example**
CS	OK,<flow>,<UPL>, <LPL>,<p_units>, 0,<R/S>,0/	**Current Status:** returns the following values: <flow>: current flow rate* in ml/min <UPL>: Upper Pressure Limit <LPL>: Lower Pressure Limit <p_units>: pressure units <R/S>: Run/Stop state, where 0 = stop, 1 = run *CP pumps return flow rate set point	OK,12.00, 10000,0000, psi,0,0,0/
FIxxxx	OK,FI:<flow>/	**Flow Input:** sets the flow rate using up to 5 digits. If the entered value exceeds the maximum allowable flow rate of the pump, the flow rate will be automatically set to the maximum allowable flow rate.	OK,FI:01200/
GS	OK,GS:<seal>/	**Get Seal:** returns the seal-life stroke counter value.	OK,GS:7/
ID	OK, <ID> Version <ver>/	**ID:** returns the firmware version and part number. <ID>: firmware part number <ver>: firmware revision	OK, 196000 Version 1.0.0/
KD	OK/	**Keypad Disable:** disables front panel buttons.	OK/
KE	OK/	**Keypad Enable:** enables front panel buttons.	OK/
MF	OK,MF:<max_flow>/	**Maximum Flow:** returns the maximum allowable flow rate for the pump, in ml/min.	OK,MF:12.00/
PI	OK,<flow>,<R/S>, <p_comp>,<head>,0,1, 0,0,<UPF>,<LPF>, <prime>,<keypad>, 0,0,0,0,<stall>/	**Pump Information:** returns the current pump information. <flow>: current flow rate* in ml/min <R/S>: run/stop state, where 0 = stop, 1 = run <p_comp>: manual pressure compensation value <head>: head identification <UPF>: upper pressure fault status <LPF>: lower pressure fault status <prime>: 0 = not in prime, 1 = in prime <keypad>: 0 = keypad buttons enabled, 1 = disabled <stall>: 0 = no motor stall fault, 1 = faulted *CP pumps return flow rate set point	OK,12.00,0,0, S10D,0,1,0, 0,0,0,0,0,0, 0,0,0,0/
RE	OK/	Reset: reset all user adjustable values to factory defaults. This includes the flow rate, upper pressure limit, lower pressure limit, selected solvent, flow rate compensation, and CP values.	OK/
RF		Read Faults: returns status of all fault indicators, where 0 = no fault, 1 = fault. <stall>: motor stall fault <UPF>: upper pressure fault status <LPF>: lower pressure fault status	OK,0,0,0/
RU	OK/	Run: run the pump.	OK/
ST	OK/	Stop: stop the pump.	OK/

General Commands			
Command	**Response**	**Description**	**Example**
UC	OK,UC:<user_comp>/	**User Compensation:** returns the user flow rate compensation, where xxx.x = xxx.x % e.g. UC:102.5/ = 102.5% compensation (+2.5%)	OK,UC:100.0/
UCXXXX	OK,UC:<user_comp>/	**User Compensation:** stores the user flow rate compensation, where xxx.x = xxx.x % e.g. UC102.5 = 102.5% compensation (+2.5%) input range: 0850 to 1150 (i.e. ± 15.0%)	OK,UC:100.0/
ZS	ZS:OK/	**Zero Seal:** reset the seal-life stroke counter to zero.	ZS:OK/
#	No response	Clears all characters from the command buffer.	

Leak Sensor Commands

The following commands are active ONLY for instruments with a LEAK SENSOR. All other instruments will respond with error message Er/.

Leak Sensor Commands			
Command	**Response**	**Description**	**Example**
LS	OK,LS:<leak>/	**Leak Status:** returns the leak sensor status. 0 = no leak detected 1 = leak detected	OK,LS:0/
LMx	OK,LM:<mode>/	**Leak Mode:** sets the leak sensor mode. 0 = leak sensor disabled 1 = detected leak does not cause fault 2 = detected lead does cause fault	OK,LM:0/

Pressure Commands

The following commands are active ONLY for instruments with a PRESSURE SENSOR. All other instruments will respond with error message Er/.

Pressure Commands			
Command	**Response**	**Description**	**Example**
PR	OK,<pressure>/	**Pressure:** returns the current operating pressure.	OK,0897/
MP	OK,MP:<max_pressure>/	**Maximum Pressure:** returns the maximum allowable pressure for the pump.	OK,MP:10000/
LP	OK,LP:<LPL>/	**Lower Pressure:** returns the lower pressure limit.	OK,LP:0000/
UP	OK,UP:<UPL>/	**Upper Pressure:** returns the upper pressure limit.	OK,UP:10000/
LPxxxxx	OK/	**Lower Pressure:** stores the lower pressure limit. psi input format: LP200 = 200 psi bar input format: LP200 = 20.0 bar MPa input format: LP200 = 2.00 MPa	OK/

Pressure Commands			
Command	**Response**	**Description**	**Example**
UPxxxxx	OK/	**Upper Pressure:** stores the upper pressure limit. psi input format: LP200 = 200 psi bar input format: LP200 = 20.0 bar MPa input format: LP200 = 2.00 MPa	OK/
PU	OK,<p_units>/	**Pressure Units:** returns the pressure units.	OK,psi/

Solvent Select Commands The following commands are active ONLY for instruments featuring Solvent Select. All other instruments will respond with error message Er/.

Solvent Select Commands			
Command	**Response**	**Description**	**Example**
RS	OK,<solvent>/	**Read Solvent:** returns the solvent value.	OK, 121/
SSxxx	OK/	**Set Solvent:** stores the solvent value.	OK/

Analog Input Commands The following commands are used to configure the analog input located on the rear panel terminal connector.

Analog Input Commands			
Command	**Response**	**Description**	**Example**
AM	OK,AM:<mode>/	**Analog Mode:** returns the input mode. 0 = voltage input (0 – 10 Vdc) 1 = current input (4 – 20 mA)	OK,AM:0/
AMx	OK,AM:<mode>/	**Analog Mode:** sets the input mode. 0 = voltage input (0 – 10 Vdc) 1 = current input (4 – 20 mA)	OK,AM:0/
AE	OK,AE:<mode>/	**Analog Enable:** returns the analog input enable (override), which activates analog flow control regardless of the physical enable line state. 0 = override disabled: must connect enable line on external control board to activate analog input. 1 = override enabled: activates analog input regardless of external enable line state.	OK,AE:0/
AEx	OK,AE:<mode>/	**Analog Enable:** sets the analog input enable (override), which activates analog flow control regardless of the physical enable line state. 0 = override disabled: must connect enable line on external control board to activate analog input. 1 = override enabled: activates analog input regardless of external enable line state.	OK,AE:0/

4-20mA Current Calibration Commands

The following commands are active ONLY when 4-20mA CURRENT INPUT MODE is selected. When 0-10V VOLTAGE INPUT is selected, instruments will respond with error message Er/.

4-20mA Current Input Calibration Commands			
Command	**Response**	**Description**	**Example**
IO	OK,IO:<i_offset>/	**Current Offset:** returns offset value used in 4-20mA calibration, in A/D counts.	OK,IO:184/
IOxxxx	OK,IO:<i_offset>/	**Current Offset:** sets offset value used in 4-20mA calibration, in A/D counts. input range: 0 to 1000	OK,IO:184/
IS	OK,IS:<i_span>/	**Current Span:** returns span (gain) value used in 4-20mA calibration, in A/D counts.	OK,IS:816/
ISxxxx	OK,IS:<i_span>/	**Current Span:** sets span (gain) value used in 4-20mA calibration, in A/D counts. input range: 0 to 1000	OK,IS:816/

0-10V Voltage Input Calibration Commands

The following commands are active ONLY when 0-10V VOLTAGE INPUT MODE is selected. When 4-20mA CURRENT INPUT is selected, instruments will respond with error message Er/.

0-10V Voltage Input Calibration Commands			
Command	**Response**	**Description**	**Example**
VO	OK,VO:<v_offset>/	Voltage Offset: returns offset value used in 0-10V calibration, in A/D counts.	OK,VO:5/
VOxxxx	OK,VO:<v_offset>/	Voltage Offset: sets offset value used in 0-10V calibration, in A/D counts. input range: 0 to 1000	OK,VO:5/
VS	OK,VS:<v_span>	Voltage Span: returns span (gain) value used in 0-10V calibration, in A/D counts.	OK,VS:1000/
VSxxxx	OK,VS:<v_span>	Voltage Span: sets span (gain) value used in 0-10V calibration, in A/D counts. input range: 0 to 1000	OK,VS:1000/

C.2 Rear Panel 10-Pin Terminal Board Connector

A 10-pin terminal board connector is provided on the back panel. Any device capable of providing the proper run/stop logic level or flow rate control voltage can be used as a remote controlling device for pump operation via this connection. The terminal board connector may be removed for ease of wiring by pulling firmly rearward. Care should be taken to reinsert the connector firmly and in the proper orientation; misalignment is possible.

Pin	Function
10	VOLTAGE IN (V+)
9	VOLTAGE COM (V-)
8	RELAY NORMAL OPEN
7	RELAY NORMAL CLOSED
6	RELAY COMMON
5	FAULT OUTPUT
4	VOLTAGE MODE ENABLE
3	RUN INPUT
2	STOP INPUT
1	COM

C.3 Relay Output

This output is produced internally by a reed relay which has SPDT contacts with a 0.25 amp maximum, 50 VDC maximum, 0.2 ohm rating. While the pump is in a normal state of operation (no faults present), the relay terminals NORMAL CLOSED and RELAY COMMON will be electrically connected. While the pump is in a faulted state, the relay will toggle, and the NORMAL OPEN and RELAY COMMON terminals will become electrically connected.

C.4 General Information on Run, Stop, and Enable Inputs

The RUN INPUT, STOP INPUT, and ANALOG INPUT ENABLE inputs operate from an internal 3.3 VDC source. To activate any of these inputs, connect it to COM. Any device capable of switching 0.008 amps can be connected between the RUN INPUT, STOP INPUT, or ANALOG INPUT ENABLE input and COM, such as: a switch contact, a relay contact, an open collector output, an open drain output, or any output with a high logic level output of 2.6 to 5.0 volts and a low logic level output of 0.0 to 0.4 volts. A switch contact or a relay contact is preferred since this type of connection will provide isolation between the pump and the controlling device. The COM terminal is internally connected to the pump's chassis ground and should be connected to

the controlling device's ground or zero volt terminal when the controlling device has an open collector output, an open drain output, or any output with logic level output.

C.4.1 Run and Stop Inputs

The pump's motor can be commanded to run or stop from the back panel inputs. There two modes of operation for the run and stop inputs:

Dual Signal Pulse

In this mode of operation both the RUN INPUT and STOP INPUT are normally unconnected (floating) or at a high logic level (+3.3V). To start the pump, pulse the RUN INPUT to a low logic level (<0.4V) for a minimum of 250 ms. To stop the pump, pulse the STOP INPUT to a low logic level for a minimum of 250 ms.

Single Signal Level

To enable this mode of operation, the STOP INPUT must be held at a low logic level during power-up. To start the pump, put a low logic level on the RUN INPUT. To stop the pump, put a high logic level on the RUN INPUT.

C.4.2 Voltage Input Enable

When activated (low logic level), the VOLTAGE MODE ENABLE disables flow rate control via the front panel, and enables flow rate control via the 0-10V voltage input. To enable voltage input mode, connect the voltage input enable pin (pin 4) to ground (pin 1).

C.4.3 Analog Input Source

Control of the flow rate set point is possible via the analog input located on pins 9 and 10. To use an analog input source, the proper input mode must be selected, and the analog input must be enabled. To select 0-10Vdc VOLTAGE CONTROL, use the AM0 command or select voltage mode in the setup menu. To select 4-20mA CURRENT CONTROL, use the AM1 command or select current mode in the setup menu. Note that selecting an input mode does not enable the analog input.

C.4.4 Analog Input Enable

When activated (low logic level), the ANALOG INPUT ENABLE disables flow rate control via the front panel, and enables flow rate control via the analog input (0-10VDC or 4-20mA). To enable analog input mode, connect the analog input enable pin (pin 4) to ground (pin 1). Alternatively, analog input mode may be enabled without making this connection by using the AE1.

C.4.5 Voltage Input

The remote voltage flow control is implemented by connecting a negative input to the rear panel VOLTAGE COM connection and a positive input to the VOLTAGE IN connection. A 0-10 VDC input corresponds to a flow rate range between 0 ml/min and the pump’s maximum flow rate. The voltage control mode must be enabled as described above. The voltage source which drives the VOLTAGE IN and VOLTAGE COM connections must be isolated from the safety ground to prevent a ground loop current. If the displayed flow rate jumps up and down erratically, suspect a ground loop problem. Flow rate instabilities may exist for input voltages below 10mV.

DECLARATION OF CONFORMITY

CE

Application of Council Directive:	2014/30/EU – EMC Directive 2014/35/EU – Low Voltage Directive 2011/65/EU – Restriction of Hazardous Substances
Manufacturer's Name:	Teledyne Isco
Manufacturer's Address:	4700 Superior Lincoln, Nebraska 68504-1398 USA P.O. Box 82531, Lincoln, NE 68501-2531 Phone: +1 (402) 464-0231 Facsimile: +1 (402) 465-3799
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments
Trade Name/Model No:	Reaxus 6010R
Year of Issue:	2015

Standards to which Conformity is Declared:

EMC Directive		
EN 55011:2010		
EN 61236-1:2013		
EN 61000-4-2:2009		
EN 61000-4-3:2006/A1:2007/A2:2010		
EN 61000-4-4:2012		
EN 61000-4-5:2014		
EN 61000-4-6:2014		
EN 61000-4-8:2010		
EN 61000-4-11:2004		
LVD Directive		
EN 61010-1:2010		
RoHS2 Directive		
EN 50581:2012		

The undersigned, hereby declares that the design of the equipment specified above conforms to the above Directive(s) and Standards as of February 16, 2016.

USA Representative

Edward J. Carter
Director of Engineering

TELEDYNE ISCO
A Teledyne Technologies Company

Teledyne Isco Two Year Limited Factory Service Warranty*

This warranty exclusively covers Teledyne Isco instruments, providing a two-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 desiccant, pH sensors, charts, ribbon, lamps, tubing, and glassware; fittings and wetted parts of valves; check valves, pistons, piston seals, wash seals, cylinders, pulse damper, diaphragms, inlet lines and filter elements, 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 material authorization number issued by Teledyne Isco.

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

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

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

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

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

Shipping Address: Teledyne Isco - Attention Repair Service
4700 Superior Street
Lincoln, NE 68504 USA

Mailing Address: Teledyne Isco
PO Box 82531
Lincoln, NE 68501 USA

Phone: Repair service: (800) 775-2965 (lab instruments)
(866) 298-6174 (samplers & flow meters)
Sales & General Information: (800) 228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: IscoService@teledyne.com

January 10, 2017 P/N 60-1002-041

TELEDYNE ISCO
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