Table Of Contents

7. MACRO LINEAR PUMP MODULE

7.1 DESCRIPTION (Figure 7.1)

The Macro Linear Pump Module, hereafter referred to as the Pump Module, is comprised of the following major components; a ceramic piston and cylinder set, two fitting sets and a case. The Pump Module is within the liquid path and is designed to be detached from the Actuator Module and completely disassembled for ease of cleaning, decontamination and sterilization. The Pump Module is designed to be used in conjunction with the 20-pitch Actuator Module. The Pump Module will not mechanically fit onto a standard 40-pitch Actuator Module.

7.2 OPERATION

The Pump Module is a piston/cylinder arrangement providing positive displacement. The Pump Module contains a ceramic piston that is selectively rotated and reciprocated by the Actuator Module. The piston is connected to the Actuator Module through a unilaterally flexible coupling located on the end of the Actuator Module's lead screw. The piston incorporates a flat on one end that provides valving of the pump to either the intake or discharge ports.

The piston's home position is with the piston flat aligned with the discharge port and retracted to fill the cylinder with liquid. The piston is pushed forward forcing the required amount of liquid through the discharge port. Depending on the Controller Module mode, the piston will either stop after completing a dispense and wait until requested to dispense again or will automatically rotate to the intake port, retract to fill the chamber and then rotate back to the discharge port.

The end of the piston is never drawn back beyond the intake and discharge ports in normal operation. The piston flat allows only one port to communicate with the interior of the pump cylinder at any time. The effect of this is positive mechanical valving, eliminating the need for check valves under normal operations.

The pump, which cannot be driven by liquid pressure, essentially acts as a closed valve when the unit is not in operation.

7.2.1 Piston/Cylinder Set

The piston/cylinder set is constructed of high density alumina or magnesium stabilized zirconia ceramic. The ceramics are compatible with most acids and bases. The piston/cylinder set has a clearance between the piston and cylinder wall of approximately .00005" which minimizes fluid slip.

The ceramic piston operates within the ceramic cylinder with no lubrication other than the liquid being dispensed or metered. The natural crystalline structure of the ceramic displays zero porosity ensuring zero retention and carry over of one liquid to the next.

Figure 7.1 Macro Linear Pump Module

The ceramic material's mechanical and thermal stability allows the Pump Module to be sealed by virtue of a close running clearance between the piston and the cylinder bore. This means that no compliant dynamic seals are used eliminating a part requiring frequent replacement in traditional pump designs.

7.3 INSTALLATION

No installation of the Pump Module is required. Refer to section 7.5.2.1 for assembly and disassembly of the Pump Module to the Actuator Module. Refer to Chapter 2 for instructions on setting up the system for operation.

7.4 OPTIONS

IVEK Corporation offers a variety of options to best meet the customers' needs. Following is a list and description of available options for the Pump Module. Refer to the Title Section of this manual for the list of options provided with this system.

7.4.1 Special Piston/Cylinder Bore Clearances or Modifications

For certain applications, special clearances are required for the piston/cylinder bore. IVEK Corporation determines these clearances by performing application tests using the application fluid. Contact IVEK Corporation Applications Department for more information.

For certain applications, special machined modifications are required for the piston/cylinder. IVEK Corporation determines these modifications by performing application tests using the application fluid. Contact IVEK Corporation Applications Department for more information.

7.4.2 Rinse Gland

This option provides for rinsing the rear portion of the piston with a liquid passing at a low flow rate through the annular gland. This precludes migration of the metered liquid beyond this groove, preventing it from reaching the rear of the pump. This also reduces the chance of the piston binding in the cylinder.

7.4.3 Cartridge Heater Ports/Cartridge Heaters

Optional cartridge heater ports and cartridge heaters are available. IVEK Corporation will assist the user in determining the optimum heater specification. Pump head heating is used to maintain liquid temperature. Heating is not used to increase liquid temperature.

7.4.3.1 Cartridge Heater Ports

Optional cartridge heater ports can be provided in the pump case to keep the Pump Module at an elevated temperature. The 1/8" diameter ports are located in the pump case 180^{O} apart.

7.4.3.2 Cartridge Heaters

Optional cartridge heaters can be mounted in the cartridge heater ports. A temperature controller and thermocouple may also be provided. If a controller is provided, instructions for the controller are provided in Chapter 8.

7.4.4 Fitting Sets

Fitting sets are available with the Pump Module. Each fitting set is composed of a fitting, fitting seals and fitting retainers. Table 7.1 lists the IVEK part numbers for the available fitting sets and individual fitting components.

Table 7.1 Fitting Part Numbers

Fitting Description	Fitting Material	Part Numbers		
		Fitting	Seal	Retainer
3/16" Barbed Adapter	PP	142191	142181	142084
1/4" Barbed Adapter	PP	142007		
3/8" Barbed Adapter	PP	142008		
1/2" Barbed Adapter	PP	142009		
1/8" Barbed Adapter	316 SS	142010		
3/16" Barbed Adapter	316 SS	142188		
1/4" Barbed Adapter	316 SS	142011		
3/8" Barbed Adapter	316 SS	142012		
1/2" Barbed Adapter	316 SS	142013	142181	
.250"-28 Adapter	316 SS	142025	142026	
.312"-24 Adapter	316 SS	142132	142133	
1/8" NPT	316 SS	142015	142181	
1/4" NPT	316 SS	142244		
Jaco Comp 1/4" Tubing Adapter	316 SS	142189		
Jaco Comp 1/4" Tubing Adapter	PP	142192		
Swagelok Compt 1/8" Tubing Adapter	316 SS	142200		
Swagelok Compt 1/4" Tubing Adapter	316 SS	142197		
O-Ring Face Seal Adapter	316 SS	142001		142084
Sanitary Flange Adapter	316 SS	142374	142181	**

** Part of 142374

7.5 MAINTENANCE

CAUTION

Never forcibly remove or install the piston into the cylinder housed within the Pump Module. Damage to the equipment may result.

7.5.1 Preventative Maintenance

The ceramic components for the Pump Module have been designed to last for millions of repetitions without wear. Preventative maintenance includes careful handling of the piston fabrication and cylinder housing when they have been removed from the Pump Module. Always take great care when removing the piston fabrication from the cylinder and replacing the piston fabrication into the cylinder. If the cleaning procedure includes removing the Pump Module and individually cleaning separate parts, always keep the Pump Module parts together, each piston fabrication with the cylinder housing to which it was originally mated. The number on the piston fabrication should match the number on the cylinder housing. Never clean in such a way that the ceramics can vibrate against each other or chipping may result.

CAUTION

Ceramic piston/cylinder sets are particularly sensitive to neglect and may seize if allowed to dry out without adequate cleaning.

7.5.1.1 General Applications; Routine Cleaning Procedure.

1. Disconnect intake tubing from process liquid supply container.
2. Cycle pump in continuous mode until remaining process liquid has been purged from the Pump Module liquid path.
3. Connect the intake tubing to the cleaning liquid supply container.
4. Cycle pump in continuous mode at a high prime rate to flush the cleaning liquid through the entire liquid path.

NOTE

Routine flushing with a compatible liquid after shutdown may suffice for most applications.

7.5.2 Assembly/Disassembly Procedures (Figure 7.2 and Figure 7.3)

The Pump Module contains the following replaceable parts. Also contained in this section are the procedures for assembling and disassembling the Pump Module from the Actuator Module.

- Adapter Ring (2)
- O-Ring (6)
- End Cap and Seal (7)
- Piston Fabrication (10)
- Castellated Sleeve (4)
- Spacer (3)
- Case (5)
- Cylinder (9)
- Seal (8)

WARNING

Make sure the power is OFF and all hazardous liquids have been flushed from the system prior to performing any disassembly or assembly procedures.

7.5.2.1 Pump Module (Figure 7.3)

IVEK systems are shipped with the Pump Module assembled onto the Actuator Module. The following procedures are only necessary if you received a new Pump Module or for disassembly and assembly if removing the Pump Module for maintenance or repair.

NOTE

Record the port orientation prior to removal and duplicate during assembly.

Disassembly:

1. Loosen (do not remove) four #10-32 socket head cap screws (3) securing Pump Module (5) to Actuator Module (1).
2. Turn Pump Module (5) slightly counterclockwise and slowly remove.

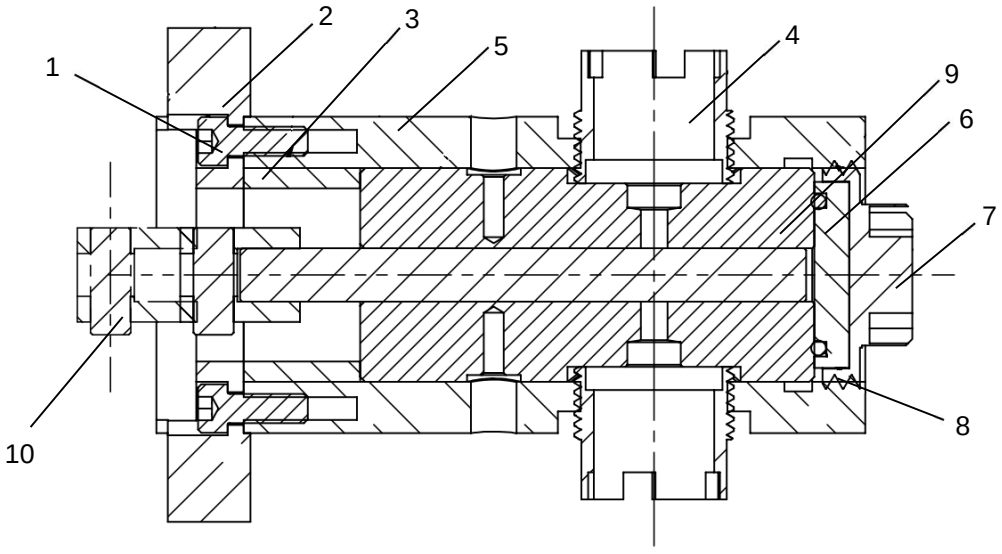

Figure 7.2 Macro Linear Pump Module Components Assembly/Disassembly

NOTE

Piston (4) will stay attached to coupling (2).

3. Loosen two thumb screws (8) securing access cover (9) to Actuator Module (1).
4. Slide access cover (9) to one side.
5. Loosen (do not remove) two set screws (6) securing piston (4) in hub (2).
6. Remove piston (4).

Assembly:

1. Loosen two thumb screws (8) securing access cover (9) to Actuator Module (1).
2. Rotate access cover (9) to one side.
3. Remove piston (4) from Pump Module (5).
4. Slide the drive pin on piston (4) into coupling (2) slot. Make sure the drive pin is fully inserted and is resting against the bottom of the slot (7).
5. Secure piston (4) in coupling (2) with two set screws (6). Tighten firmly and evenly.
6. Rotate access cover (9) on Actuator Module (1) back into place and tighten two thumb screws (8).
7. Carefully align Pump Module (5) over piston (4) and gently slide it over piston (4) and four screws (3) until it abuts Actuator Module (1). Turn slightly clockwise and secure with four #10-32 socket head cap screws (3).

NOTE

Make sure the intake and discharge ports are properly orientated. (same as prior to removal)

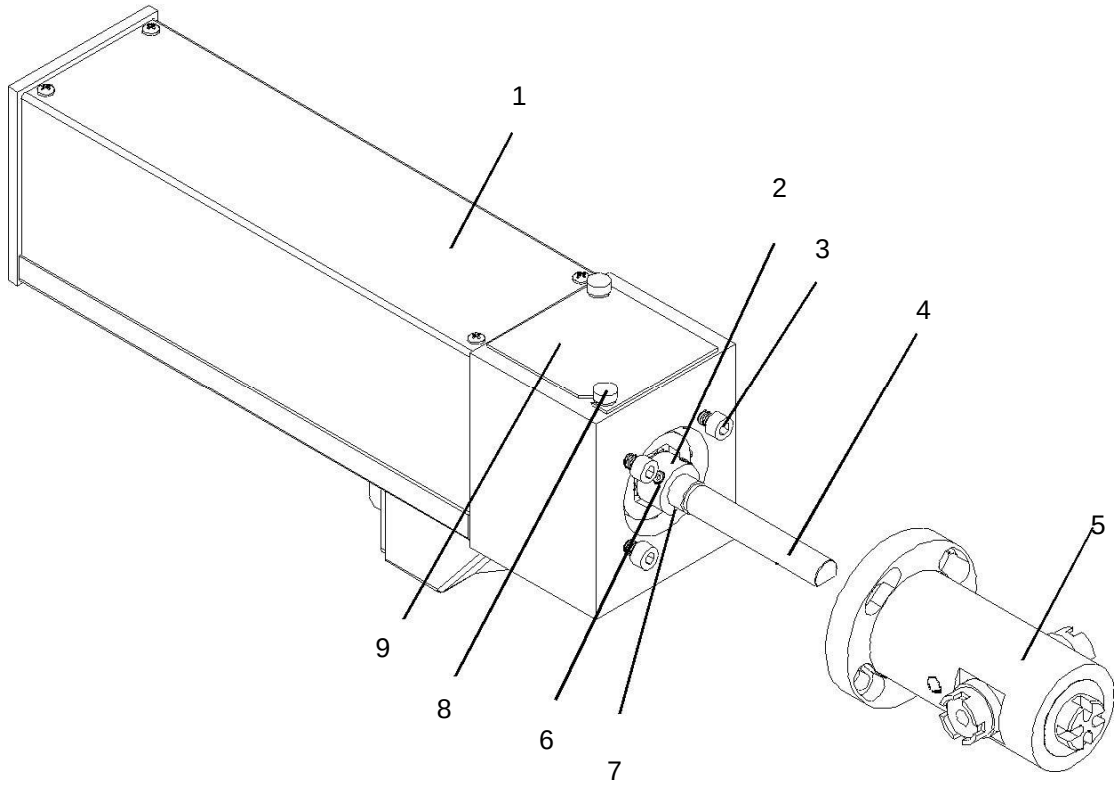

Figure 7.3 Macro Linear Pump Module Assembly/Disassembly

7.5.2.2 O-Ring, End Cap and Seal (Figure 7.2 Items 6, 7 and 8)

Disassembly

1. Remove end cap (7) from case (5) by placing the spanner wrench (provided with equipment) on end cap (7) and turning in a counterclockwise direction.
2. Remove O-Ring (6) and end cap seal (8).

NOTE

If installing the same O-ring and end cap seal, make sure they are clean and free of scratches before installing.

Assembly

1. Position O-Ring (6) in end cap seal (8).
2. Place end cap seal (8), with O-ring (6) towards cylinder (9), in end cap (7).
3. Position end cap (7) on case (5) and finger tighten by turning in a clockwise direction.
4. Finish tightening using spanner wrench supplied. Torque to 3.4 N-m (30 In-lb)

7.5.2.3 Adapter Ring (Figure 7.2 Item 2)

Disassembly

1. Remove the Pump Module from the Actuator Module as described in section 7.5.2.1 steps 1 and 2 only.
2. Remove two #6-32 socket head cap screws (1) securing adapter ring (2) to case (5) and remove adapter ring (4).

Assembly

1. Position adapter ring (2) on case (5) and secure with four #6-32 socket head cap screws (1).
2. Assemble the Pump Module onto the Actuator Module as described in section 7.5.2.1 step 7.

7.5.2.4 Cylinder, Piston Fabrication, and Spacer (Figure 7.2 Items 9, 10 and 3)

NOTE

The piston fabrication and cylinder are a matched set. If either the cylinder or piston needs replacing, both parts must be replaced.

Disassembly

1. Remove the Pump Module from the Actuator Module as described in section 7.5.2.1.
2. Remove end cap (7) from case (5) by placing the spanner wrench (provided with equipment) on end cap (7) and turning in a counterclockwise direction.
3. Remove O-ring (6) and end cap seal (8).
4. Loosen and remove both castellated nuts (4).
5. Remove adapter fittings and port seals.
6. Slide piston fabrication (10), cylinder (9) and spacer (3) out of case (5).

Assembly

1. Slide spacer (3), cylinder (9) and piston fabrication into case (5).
2. Align cylinder (9) ports and position port seals, adapter fittings and castellated nuts (4) and **finger tighten** castellated nuts (4).
3. Position O-Ring (6) in end cap seal (8).
4. Place end cap seal (8), with O-ring (6) towards cylinder (9), in end cap (7).
5. Position end cap (7) on case (5) and tighten by turning in a clockwise direction using the spanner wrench (supplied with equipment). Torque to 3.4 N-m (30 In-lb)

6. Tighten a maximum of 1.4 N-M (12 in. lbs.) the two castellated nuts (4) using the spanner wrench (supplied with equipment).
7. Assemble the Pump Module onto the Actuator Module as described in section 7.5.2.1.

7.5.2.5 Case (Figure 7.2 Item 5)

Disassembly

1. Remove the Pump Module from the Actuator Module as described in section 7.5.2.1.
2. Remove end cap (7) from the Pump Module by placing the spanner wrench (provided with equipment) on end cap (6) and turning in a counterclockwise direction.
3. Remove O-ring (6) and end cap seal (8).
4. Remove both castellated nuts (4).
5. Remove adapter fittings and port seals.
6. Slide piston fabrication (10), cylinder (8) and spacer (3) out of case (5).
7. Remove two #6-32 socket head cap screws (1) securing adapter ring (2) to the case (5) and remove adapter ring (4).

Assembly

1. Position adapter ring (2) on case (5) and secure with four #6-32 socket head cap screws (1).
2. Slide spacer (3), cylinder (9) and piston fabrication into case (5).
3. Align cylinder (9) ports and position port seals, adapter fittings and castellated nuts (4) and **finger tighten** castellated nuts (4).
4. Position O-Ring (6) in end cap seal (8).
5. Place end cap seal (8), with O-ring (6) towards cylinder (9), in end cap (7).
6. Position end cap (7) on case (5) and torque to 3.4 Nm (30 in-lbs) by turning in a clockwise direction using the spanner wrench (supplied with equipment).
7. Tighten a maximum of 1.4 Nm (12 in-lbs.) the two castellated nuts (4) using the spanner wrench (supplied with equipment).
8. Assemble the Pump Module onto the Actuator Module as described in section 7.5.2.1.

7.6 PROBLEM GUIDE

7.6.1 Piston Seized In The Cylinder (Figure 7.3)

If the piston seizes in the cylinder perform the following steps.

CAUTION

DO NOT TRY TO FORCE THE PISTON FREE!

Damage to the piston/cylinder set or Actuator Module may occur.

1. Loosen two thumb screws (8) securing access cover (9) to Actuator Module (1).
2. Slide access cover (9) to one side.
3. Remove four bolts (3) securing Pump Module (5) to Actuator Module (1).
4. Turn the Pump Module to gain access to the two screws (6) securing piston (4) in hub (2) and loosen (do not remove) two screws (6).
5. Carefully remove Pump Module (5) from Actuator Module (1).
6. Soak the Pump Module in a liquid compatible with the materials and process liquids.
7. After soaking, try removing the piston from the cylinder by applying a light torque to the piston using only your fingers (no tools).

If the aforementioned procedures fail, contact IVEK Technical Support Department for assistance. It may be necessary to ship the Pump Module back to the factory. Provide a note describing, in detail, what conditions caused the seizure. It may also be necessary to return the Actuator Module along with the Pump Module should realignment of the Pump Module drive components be required.

Table 7.3 contains a list of possible problems, causes and solutions for the Pump Module.

7.7 SPECIFICATIONS

Table 7.2 lists the volumetric output of the different size Pump Modules. Refer to the Title Page section of this manual for the Pump Module size provided with your system.

Table 7.2 Volumetric Output Of Macro Linear Pump Modules

Size	Chamber Capacity (µl)	Resolution (µl/µ Step)
B	400	0.04
C	1000	0.1
D	2000	0.2

7.8 MODEL NUMBER

The model number provides important information about the specifics of your Pump Module. Refer to this number when calling IVEK Technical support. The model number for your Pump Module is located in the Title Page section of this manual.

Macro Linear **032106 -** **#** **#** **###**

Linear Pump Case
- **1** - Without Heater Option
- **2** - With Heater Option

O-Ring Material
- **1** - Buna-N
- **2** - Ethylene Propylene
- **3** - Kalrez
- **4** - Polyurethane
- **5** - Silicone
- **6** - Teflon
- **7** - Teflon Encapsulated Silicone
- **8** - Viton

Piston/Cylinder Set
- **007** - B-Size Alumina
- **008** - B-Size Zirconia
- **009** - C-Size Alumina
- **010** - C-Size Zirconia
- **011** - D-Size Alumina
- **012** - D-Size Zirconia
- **107** - B-Size Alumina W/Gland
- **108** - B-Size Zirconia W/Gland
- **109** - C-Size Alumina W/Gland
- **110** - C-Size Zirconia W/Gland
- **111** - D-Size Alumina W/Gland
- **112** - D-Size Zirconia W/Gland

7.9 ILLUSTRATED PARTS BREAKDOWN

The illustrated parts breakdown (Figures 7.4) contains replacement parts for the Macro Linear Pump Module.

Table 7.3 Common Operational Problems And Solutions

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
Air evident in discharge line.	Loose tubing connection at intake fitting.	Tighten fittings.
	Loose/Damaged intake port seals.	Tighten/replace port seals.
	Loose/Damaged End Cap Seals or damaged intake fitting.	Clean, inspect and replace if necessary.
	Cavitation.	Increase inlet tubing size, reduce Pump Module speed or increase feed pressure.
Piston seizing	Liquid polymerized or particulate materials entrapped between piston and cylinder.	Disassemble Pump Module and clean all wetted surfaces.
Fluid leaks	Improperly seated or worn end cap seal.	Disassemble Pump Module and clean all wetted surfaces, inspect components and replace if necessary.
	Loose/damaged output port seal, output tubing, or damaged fitting.	Inspect, tighten or replace if necessary.
Fluid not moving in tubing when priming, dispensing or metering.	Pump Module not properly oriented on Actuator Module.	Make certain that port holes in Pump Module line up with flat on piston.

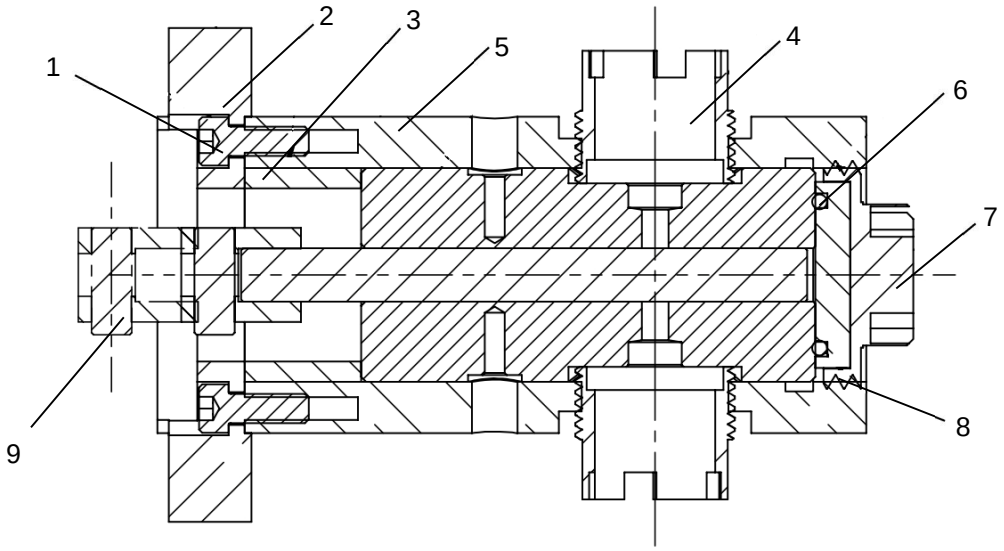

Figure 7.4 Macro Linear Pump Module (Sheet 1 of 2)

	PART NUMBER	DESCRIPTION	UNITS PER ASSY
	032106-#####	**Macro Linear Pump Module**	1

Model # Tab	Dwg Index #	Part #	Description	Qty
	1	182011-C06038	Screw, Soc HD Cap, 18-8 Inch; #6-32 X 0.38 Long	4
	2	032050	Adapter Ring	1
	3	032108	Spacer	1
	4	142084	Castellated Threaded Sleeve	2
	8	092285	Seal, End Cap W/-016 O-Ring Groove	1
	7	092250	Cylinder End Cap	1
032106 # ####			**LINEAR PUMP CASE**	
1	5	032104-1	Linear Pump Case Without Heater Option	1
2	5	032104-2	Linear Pump Case With Heater Option	1
2	NS	182005-C06019	Screw, But HD Soc Cap, 18-8 Inch; #6-32 X .18 Long	1
032106-# # ###			**O-RING MATERIAL**	
1	6	142294-01601	O-Ring; -016 Buna -N	1
2	6	142294-01602	"; -016 Ethylene Propylene	1
3	6	142294-01603	"; -016 Kalrez	1
4	6	142294-01604	"; -016 Polyurethane	1
5	6	142294-01605	"; -016 Silicone	
6	6	142294-01606	"; -016 Teflon	1
7	6	142294-01607	"; -016 Teflon Encapsulated Silicone	1
8	6	142294-01608	"; -016 Viton	1
032106-# # ###			**PISTON/CYLINDER SET**	
007	9	022218-007	Piston/Cylinder Set; B-Size Alumina	1
008	9	022218-008	" ;B-Size Zirconia	1
009	9	022218-009	" ;C-Size Alumina	1
010	9	022218-010	" ;C-Size Zirconia	1
011	9	022218-011	" ;D-Size Alumina	1
012	9	022218-012	" ;D-Size Zirconia	1
107	9	022218-107	" ;B-Size Alumina W/Gland	1
108	9	022218-108	" ;B-Size Zirconia W/ Gland	1
109	9	022218-109	" ;C-Size Alumina W/Gland	1
110	9	022218-110	" ;C-Size Zirconia W/Gland	1
111	9	022218-111	" ;D-Size Alumina W/Gland	1
112	9	022218-112	" ;D-Size Zirconia W/Gland	1

NS = Not Shown

Figure 7.4 Macro Linear Pump Module (Sheet 2 of 2)

CHAPTER REVISIONS

E	11/08/22	Per DCR/N 21369 changed resolution units from µl to µl/µ Step on Page 9.
D	02/24/21	Per DCR/N 20389 added additional torque and minor updates.
C	11/07/18	Per DCR/N 18686 added torque to section 7.5.2.5 Assembly step 5.
B	10/07/08	Per DCR/N added torque for castellated nuts.
A	05/27/03	Refer to DCR/N NO: 9018 and added Model Number
-	11/12/97	Original release