MP-1 & MP-2
Peristaltic Pumps

D30075 • 961012

Spectrum Chromatography
P.O. Box 672026
Houston, TX 77267-2026

Toll-free (US & Canada)	**(800) 459-9700**
Elsewhere	**(281) 443-2900**
Fax	**(281) 443-3100**
Email	**sales@lplc.com**

Contents

Section Title Page

Figures

Figure Title Page

Tables

Table Title Page

1 INTRODUCTION

1.1 DESCRIPTION

The Spectra/Chrom® MP-1 and MP-2 Peristaltic Pumps are designed for low pressure chromatographic and general laboratory fluid delivery applications. The MP-1 Peristaltic Pump is engineered for precise fluid delivery at low to medium flow rates ranging from 0.03 ml/min to 228 ml/min. The MP-2 Peristaltic Pump provides precise fluid delivery at medium to high flow rates ranging from 1.80 ml/min to 2280 ml/min. Both pumps are capable of delivering 20 psi (140 kPa) of continuous pressure on up to three fluid delivery channels.

The MP Peristaltic Pumps feature a calibrated linear speed control designed specifically for the precision required for low pressure chromatography applications. The calibrated linear pump speed control enables the operator to simply dial in the appropriate pump rpm to achieve the desired flow rate for the selected tubing.

Both pump feature communications capability for integration with other Spectra/Chrom chromatography instrumentation. Each pump can automatically signal a Spectra/Chrom CF-1 Fraction Collector to maintain a constant fraction size independent of the pump speed. The pumps can also be stopped and started by remote control. When connected to the CF-1 Fraction Collector, the MP pumps can be automatically set to stop running at the end of the collection period. When used with the Spectra/Chrom Chart Recorder, the MP pumps can control the chart drive for flow rate proportional chromatograms and for chart shut-off at the end of an experiment.

The pump drives can be used with one, two, or three pump heads simultaneously to produce a variety of solvent gradients or for other fluid delivery applications. The pump drives can be used with any of the Spectra/Chrom pump heads.

TABLE 1-1. TECHNICAL SPECIFICATIONS FOR MP-1 PUMP DRIVE

Power Requirements	115±15 VAC, 100 VA 230±30 VAC, 100 VA	**Drive Speed Linearity**	±2% of full-scale from 6-54 rpm
Line Frequency	45 to 65 Hz	**Output Pressure**	20 psi (140 kPa) continuous 30 psi (240 kPa) intermittent
Dimensions	14 cm x 24 cm x 31 cm 5.4” x 9.3” x 12.3” w x h x l	**Operating Temperature**	0º to 40º C, noncondensing
Weight	5.1 kg (11 lb 5 oz)	**Speed Range**	0.5 to 60 rpm

TABLE 1-2. TECHNICAL SPECIFICATIONS FOR MP-2 PUMP DRIVE

Power Requirements	115±15 VAC, 400 VA 230±30 VAC, 400 VA	**Drive Speed Linearity**	±2% of full-scale from 60-540 rpm
Line Frequency	45 to 65 Hz	**Output Pressure**	20 psi (140 kPa) continuous 30 psi (240 kPa) intermittent
Dimensions	14 cm x 24 cm x 31 cm 5.4” x 9.3” x 12.3” w x h x l	**Operating Temperature**	0º to 40º C, noncondensing
Weight	7.9 kg (17 lb 6 oz)	**Speed Range**	15 to 600 rpm

Figure 1-1. MP-1 and MP-2 Pump Front Panel Controls

TABLE 1-3. FRONT PANEL INDICATORS

Item in Fig. 1-1	Description	Purpose
1	**Power Switch**	Control pump direction and On/Standby condition. Power is present in pump even when set to Standby.
2	**Power Indicator**	Lit when pump is on. Dark when pump is in Standby Mode
3	**Speed Knob**	Sets speed of pump to calibrated rpm.

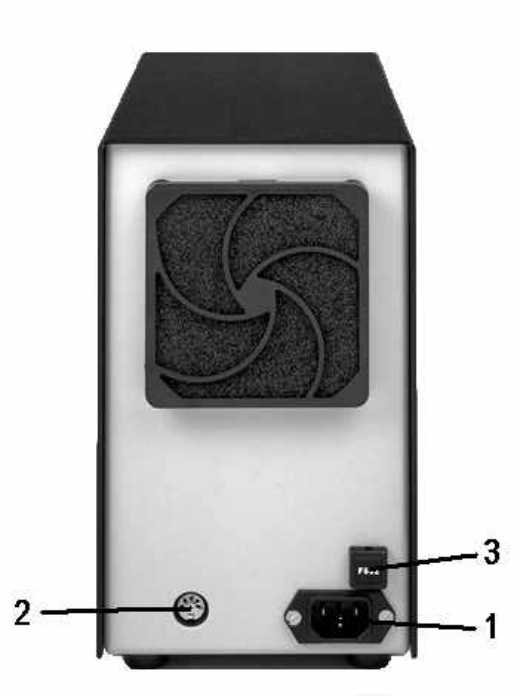

Figure 1-2. MP Pump Rear View

TABLE 1-4. REAR PANEL CONNECTORS

Item in Fig. 1-2	Name	Function
1	**Power**	IEC power cord connector for mains power
2	**Remote**	5 pin DIN connector for remote control and volumetric output
3	**Fuse**	Fuse holder for a 3AG 250V fuse. 1.5 Amp for MP-1, 115V; 1.5 Amp for MP-1, 230V. 5 Amp for MP-2, 230V; 2.5 Amp for MP-2, 230V.

2 INSTALLATION

2.1 INTRODUCTION

Both the MP-1 and the MP-2 pumps can drive 1, 2, or 3 pump heads. Each Spectra/Chrom pump head comes with mounting hardware. To mount 2 or 3 pump heads to a single drive special mounting hardware must be ordered separately. Order part 146823 to mount 2 pump heads and part 146828 to mount 3 pump heads.

For most applications we recommend using the Spectra/Chrom Fast-Load pump head, part number 146924. These can be used with any flexible tubing with a 1/16" wall and an outer diameter of 7/16" or less.

An alternate Fast-Load pump head, part number 146926 can be used with 3/32" wall flexible tubing.

In addition to the Fast-Load pump head, Spectrum also provides standard and Quick-Release pump heads for use with the MP-1 and MP-2 pumps. Each standard pump head can only be used with a single size of tubing. The Quick-Release pump heads are similar to the Fast-Load pump heads in that only the wall thickness is significant in selecting the pump head, however it is more difficult to change the tubing in a Quick-Release pump head and only a single Quick-Release pump head may be used on a pump drive.

2.2 UNPACKING

After removing your MP-1 or MP-2 pump drive from its shipping carton, examine it for signs of damage. If there is any shipping damage, immediately file a claim with the delivering carrier.

Check the contents of your shipment against the packing slip. If there are any discrepancies notify Spectrum immediately.

Save all packing materials and shipping cartons until you are sure that the pump is working properly and that all materials have been received.

2.3 INITIAL CHECKOUT

Before mounting pump heads to the drive the following checks should be performed.

1. Turn the Speed Knob (item 3 in Figure 1-1) fully counterclockwise (toward "0") and the Power Switch (item 1 in Figure 1-1) to its standby (middle) position.
2. Check the label on the bottom of the pump to be sure that your mains voltage is appropriate for the pump and, if it is, connect the line cord from the wall to the pump. The pump may be damaged and the warranty will be voided if the pump is connected to an inappropriate mains voltage.
3. Switch the Power Switch to the clockwise and then the counterclockwise positions. In either of these positions the green power light on the front of the pump should be illuminated and, if you have an MP-2 pump, the fan should be running. The motor shaft should not turn as long as the Speed Knob remains fully counterclockwise.
4. Set the power switch to the clockwise position and turn the speed knob clockwise (away from "0"). The motor shaft should turn and the speed should be variable. The shaft speed should range from 0 to about 1 turn per second on the MP-1 pump and from 0 to about 600 rpm on the MP-2 pump.
5. This completes the initial checkout. If the results of this check are unsatisfactory please consult Spectrum's service department at (800) 459-9700.

2.4 PUMP ASSEMBLY

Only minimal assembly is required to make the MP-1 and MP-2 pump operational. Simply attach one or more of the Fast-Load or Standard pump heads to the pump, insert the tubing into the pump heads, and plug the pump in.

Mounting hardware for a single pump head is supplied with each pump head. Multiple pump head mounting hardware is sold separately, order part number 146823 to mount 2 pump heads or part number 146828 to mount 3 pump heads.

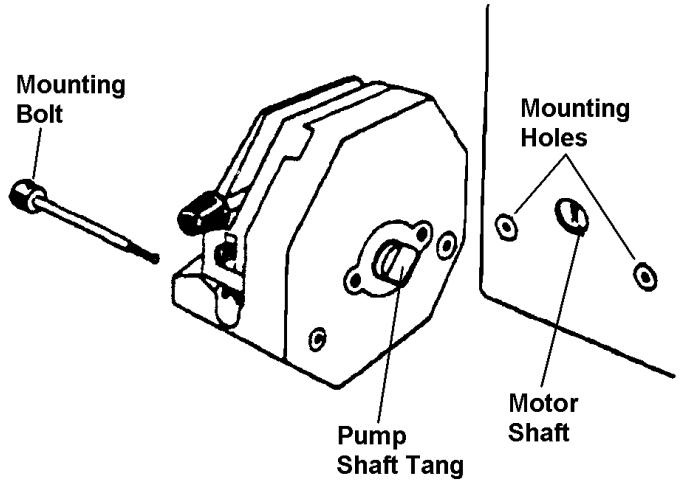

Figure 2-1. Mounting a Single Fast-Load Pump Head

To mount a single head to the pump drive, first rotate the tang on the pump drive head until it aligns with the groove in the motor shaft and then press the pump head against the front of the pump. Rotate the pump head until the mounting holes in the pump head are aligned with the mounting holes on the face of the pump, as shown in Figure 2-1. Secure the pump head to the pump drive with the 2 mounting bolts provided. To avoid cracking the pump head do not tighten these screws more than finger tight.

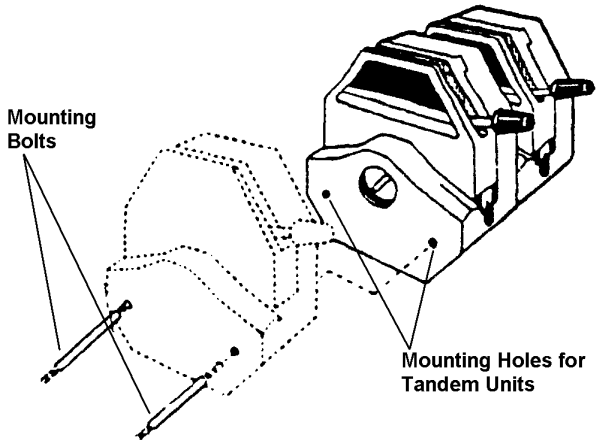

Figure 2-2. Mounting Additional Fast-Load Pump Heads

To mount more than one pump head to the pump drive, place the first head on the drive as described above but do not insert the mounting bolts; leave both mounting holes empty but aligned. While holding the first pump head in place, align the second head to it in a similar fashion. The tang

on the second pump head's shaft should be inserted into the groove in the outside of the first pump head's rotor as shown in Figure 2-2. If a third head is to be used it should now be added in the same manner.

After the pump heads are all in place they should be secured to the pump drive with the mounting bolts from the appropriate mounting hardware kit.

3 NORMAL USE

3.1 INTRODUCTION

Spectrum has 3 styles of peristaltic pump heads which may be used with the MP-1 and MP-2 pump drives. Each style of pump head is capable of pumping liquids at up to 20 psi (continuously, or 30 psi intermittently). Up to 3 pump heads may be used on a single pump drive.

The combinations which may be used are: 1, 2 or 3 Standard Pump heads; 1, 2, or 3 Fast-Load pump heads; or 1 Quick-Release Pump head alone or in combination with 1 or 2 Standard Pump Heads.

Three different tubing formulations in 6 different sizes are available for use with these peristaltic pump heads. This allows for the optimum selection of flow rate range, tubing life, and chemical compatibility to be made.

The Spectra/Chrom MP-1 and MP-2 pump drives do not include pump heads. Pump heads of a style appropriate to your application will need to be purchased separately. The Fast-Load Pump head for use with 1/16" wall tubing, part number 146924, is recommended for most applications.

3.2 FLOW RATES

The flow rate depends both upon the pump speed (rpm) and the size of the tubing. Table 3-1 shows the available flow rates for each pump drive and tubing size.

TABLE 3-1. Flow Rate Ranges

Tubing Size	13	14	15	16	17	18
OD x ID (in)	$^5/_{32}$ x $^1/_{32}$	$^3/_{16}$ x $^1/_{16}$	$^3/_8$ x $^3/_{16}$	$^1/_4$ x $^1/_8$	$^3/_8$ x $^1/_4$	$^7/_{16}$ x $^5/_{16}$
OD x ID (mm)	4.0 x 0.8	4.8 x 1.6	9.5 x 4.8	6.3 x 3.2	9.5 x 6.3	11.1 x 7.9
Part No. (LPS)	123734	123748	123844	123762	123858	123790
Part No. (LPF)	123736	123750	123846	123764	123760	123792
ml/rev	0.06	0.21	1.67	0.80	2.80	3.80
MP-1 min flow rate (ml/min)	0.030	0.105	0.833	0.400	1.40	1.90
MP-1 max flow rate (ml/min)	3.6	12.6	100	48	168	228
MP-2 min flow rate (ml/min)	1.80	6.30	50	24	84	114
MP-2 max flow rate (ml/min)	36	126	1000	480	1680	2280
Standard Pump-head	146809	146811	146815	146813	146817	14681

NOTES: 1. The Fast-Load Pump Head (Part Number 146924) will accommodate size 13, 14, 16, 17, and 18 tubing.

2. LPS - Low-Pressure Silicone. LPF - Low-Pressure Fluoroelastomer.

3.3 FAST-LOAD HEADS

The Fast-Load Pump heads are designed to be mounted to the pump drive prior to inserting the tubing. The tubing may be changed at any time without removing the pump head from the pump drive. The most common Fast-Load pump head (part 146924) is for use with tubing that has a 1/16" wall thickness.

The Fast-Load Pump heads are constructed of a glass-filled polysulfone housing and 3 stainless steel rotors. These heads allow the tubing to be changed without the use of tools while the pump head remains attached to the pump. Up to 3 Fast-Load Pump heads may be attached to an MP-1 or MP-2 pump drive.

3.4 STANDARD HEADS

The Standard Pump heads feature 3 cold-rolled steel rotors inside a clear polycarbonate housing. The simple design of these pump heads provides a very accurate pressure-independent displacement with minimal pulsation. In order to provide these features, each Standard Pump head can only accommodate a single tubing size.

The information in Table 3-1can be used to aid in selecting the proper Standard Pump head for your application.

To mount a Standard Pump Head to a pump drive, the following procedure may be used.

Figure 3-1

1. Separate the pump head halves. Place either half of the pump in your palm with the inside facing out and the inlet-outlet recesses facing up as shown in Figure 3-1. Place the rotor into the housing with the long shaft through the bearing and facing into your palm. (The shorter shaft should be facing toward you.)
1. Position the rotor so that one of the 3 rollers in between the inlet and outlet recesses (i.e. the rollers are at 12, 4, and 8 o'clock). Place a piece of tubing in the intended outlet recess and against 2 adjacent rollers as shown in Figure 3-2.

Figure 3-2

Figure 3-3

2. Insert the tubing key provided with the pump head so that the slot in the key fits completely over the rotor top plate as shown in Figure 3-2. This will push the tubing into the pump head cavity. Carefully rotate the tubing key around the pump head while pushing down on the tubing until the tubing is completely seated in the pump head cavity as shown in Figure 3-3.
3. Remove the tubing key and position the other pump head half on the rotor shaft and align the seating pins to completely mate the pump head halves.
4. Position the pump head against the pump drive. Insert the tubing key into the slot in the pump head and turn the rotor until the tang on the rotor shaft aligns with the groove in the motor drive shaft and all 4 mounting holes are aligned with those on the pump drive housing.
5. Use the four mounting thumbscrews provided with the pump head to secure it to the pump drive. Then start the pump drive and gently pull on the outlet side of the tubing to remove any excess tubing which may be present inside the pump head. (The presence of excess tubing inside the pump head will accelerate the wear rate of the tubing, decreasing its life.)

To mount more than 1 pump head to the pump, first proceed as far as step 5 above with the head to be mounted closest to the pump drive. Then, take the second pump head and proceed as far as step 5 above with it, except that you will align it not to the pump drive but rather to the pump head already in place. A third pump head can then be added outboard to the second.

The mounting hardware needed to secure 2 or 3 pump heads must be ordered separately. Use part number 146823 for mounting 2 pump heads and part number 146828 for mounting 3 pump heads.

3.5 QUICK RELEASE HEADS

The Quick-Release Pump heads are also constructed with cold-rolled steel rotors and a clear polycarbonate housing. The Quick-Release Pump heads, however, permit the tubing to be changed without the use of tools and with the pump head remaining attached to the pump drive. Also, each Quick-Release Pump head will work with a variety of tubing sizes. Only a single Quick-Release Pump head may be used on a pump drive.

Use part number 146812 to order a Quick-Release Pump head for use with size 15 tubing (3/8"OD X 3/16" ID, 3/32" wall). Use part number 146820 to order a Quick-Release Pump head for use with 1/16" wall tubing.

Figure 3-4.

To mount the Quick-Release Pump head to the pump drive, first swing the reaction arms open to expose the rotor assembly. Slowly rotate the rotor until the tang on its shaft is aligned with the groove in the pump drive shaft as shown in Figure 3-4. Then use the mounting hardware supplied with the pump head to secure the pump head to the pump. Using excessive force on the mounting hardware may crack the pump head.

Figure 3-6

Now install the tubing into the Quick-Release Pump head. Loosen the fluted knob and lift out the front half of the tubing retainer as shown in Figure 3-5. Then loop the tubing around the rollers on the rotor assembly and across the "V" grooves in the tubing retainer (see Figure 3-6). With the tubing seated, replace the tubing retainer and tighten the fluted knob until the tubing is held firmly. Finally, swing the reaction arms down and snap the latch closed. The pump will then be ready for use.

Figure 3-5

3.6 LIMITATIONS

The ultimate efficiency of a peristaltic pump is determined by the elasticity of the tubing used, the uniformity of the tubing's wall, and the occlusion provided by the rollers.

At low speed (less than 10 rpm) the pump will work best with the Standard Pump heads. The pump will not be able to maintain pressure of more than 1-2 psi using the Fast-Load and Quick-Release Pump heads.

Since the tubing will require a finite time to expand once the occlusion passes a given point, some pump efficiency will be lost when operating at high speeds. The may be noticeable with the MP-2 pump.

At high speeds (above 400 rpm) the pump will work best with silicone or low-pressure fluoroelastomer tubing. The flow rate will be less than expected if the more rigid low-pressure vinyl tubing is used.

3.7 VOLUME CONVERSION

When either the Spectra/Chrom MP-1 or MP-2 Pump drives is used with a Spectra/Chrom Fraction Collector, the fraction collector will be able to size the fraction based on the pumped volume. To do this an additional cable (part number 123859) must be used to connect the pump to the fraction collector (Figure 3-7).

Figure 3-7. Volumetric Collection Cable Connection

The relationship between the volume number used by the fraction collector and the actual measured volume depends upon which pump is used as well as the size of the tubing used. It also depends, to a lesser extent, upon the condition of the piece of tubing being used.

Table 3-3 relates the volume number to the actual volume for a variety of tubing sizes. The number listed are only approximate and are based upon using low-pressure silicone tubing of the indicated size.

If addition accuracy is desired, place a new piece of tubing in the pump and run it for 30 minutes at the speed to be used. Then measure the flow and adjust the volume number accordingly.

TABLE 3-2. Volume Conversion

Tubing Size	13	14	15	16	17	18
OD x ID (in)	$^{5}/_{32}$ x $^{1}/_{32}$	$^{3}/_{16}$ x $^{1}/_{16}$	$^{3}/_{8}$ x $^{3}/_{16}$	$^{1}/_{4}$ x $^{1}/_{8}$	$^{3}/_{8}$ x $^{1}/_{4}$	$^{7}/_{16}$ x $^{5}/_{16}$
OD x ID (mm)	4.0 x 0.8	4.8 x 1.6	9.5 x 4.8	6.3 x 3.2	9.5 x 6.3	11.1 x 7.9
Part No. (LPS)	123734	123748	123844	123762	123858	123790
Part No. (LPF)	123736	123750	123846	123764	123760	123792
MP-1 volume counts per ml	83	24.0	3.00	6.3	1.80	1.32
MP-1 ml per volume count	0.012	0.042	0.33	0.16	0.56	0.76
MP-2 volume counter per ml	5.2	1.50	0.19	0.39	0.112	0.083
MP-2 ml per volume count	0.19	0.67	5.30	2.50	8.9	12.1

3.8 CHART SPEED

When either the Spectra/Chrom MP-1 or MP-2 pump is used with a Spectra/Chrom Chart Recorder, the chart recorder can be configured to record detector response vs. pumped volume instead of detector response vs. time. To do this an additional cable (part number 124873) must be used to

connect the pump to the chart recorder. This is useful if the pump speed is varied during the course of an experiment.

Cable 124873 can also be connected to a Spectra/Chrom Fraction Collector (linking the pump, chart recorder, and fraction collector) as shown in Figure 3-8. When the fraction collector is linked to the pump and the chart recorder in this manner, both the pump and the chart recorder will stop at the end of a fraction collection run. It is not necessary to have the cable connected to the fraction collector to produce a volumetric axis chart recording.

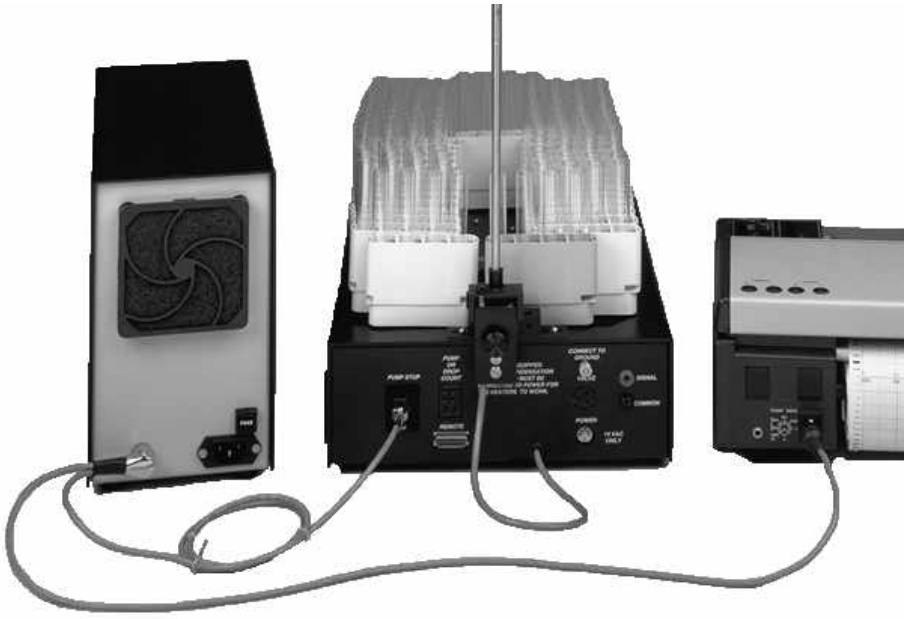

Figure 3-8. Volumetric Axis Cable Connection

The relationship between the pump flow rate and the chart speed depends upon the size of the tubing and the speed setting on the chart recorder. The volume axis on the recorder will be approximately given by:

$$axis = factor / chart$$

where axis is the volume axis rate in ml/cm, chart is the chart speed set on the recorder in cm/min (convert from cm/hr if necessary), and factor is the factor found in Table 3-4.

This is only an approximate relationship, since tubing flexibility and age will have some effect on the flow rate. If additional accuracy is desired, place a new piece of tubing in the pump and run it for 30 minutes at the speed to be used. Then measure the flow rate and adjust the axis number accordingly.

TABLE 3-3. Volume Axis Factors

Tubing Size	13	14	15	16	17	18
OD x ID (in)	$^5/_{32}$ x $^1/_{32}$	$^3/_{16}$ x $^1/_{16}$	$^3/_8$ x $^3/_{16}$	$^1/_4$ x $^1/_8$	$^3/_8$ x $^1/_4$	$^7/_{16}$ x $^5/_{16}$
OD x ID (mm)	4.0 x 0.8	4.8 x 1.6	9.5 x 4.8	6.3 x 3.2	9.5 x 6.3	11.1 x 7.9
Part No. (LPS)	123734	123748	123844	123762	123858	123790
Part No. (LPF)	123736	123750	123846	123764	123760	123792
MP-1 factor	5.88	20.0	159	77	270	357
MP-2 factor	91.74	476	2564	1220	4350	5814

3.9 TUBING SELECTION

Three different formulations of tubing are available for use with the Spectra/Chrom peristaltic pumps. The selection of a formulation should be based upon the specific application intended for the pump.

LPS (Low-Pressure Silicone) tubing is appropriate for general purpose peristaltic pump applications. It has outstanding biocompatibility and its high elasticity provides the longest tubing life amount the Spectra/Chrom peristaltic tubing products.

LPV (Low-Pressure Vinyl) tubing is specifically designed for peristaltic pump applications. The tubing exhibits minimum extractability and will not adulterate the pumped fluid, making it ideal for chromatographic applications. The smooth interior bore insures an even flow rate and the sturdy construction provides for long life. LPV tubing is recommended for general purpose and chromatographic applications involving mild aqueous solutions. See Appendix A for tubing compatibility and service life data.

LPF (Low-Pressure Fluoroelastomer) tubing is composed of a synthetic rubber which features excellent resistance to most organic solvents. LPF tubing is compatible with oils, fuels, carbon tetrachloride, xylene, toluene, and many other aromatic and aliphatic compounds. LPF tubing is recommended for applications involving corrosive or organic process fluids.

Only Spectra/Chrom tubing should be used. Spectrum exercises very strict control over the tubing dimensions and formulation to insure maximum tubing life and delivery accuracy.

Spectra/Chrom LPF and LPS tubing can be autoclaved by standard procedures. LPV tubing can be sterilized by two methods: (1) Autoclaving to a maximum temperature of 121ºC at 15 psi for 30 minutes and cooling at 65ºC in dry heat for 2½ hours maximum, or (2) immersion in standard germicide solutions or by ethylene oxide sterilization.

4 GRADIENT GENERATION

4. 1 INTRODUCTION

Peristaltic pumps are frequently used to generate low pressure gradients for chromatography, as well as for other applications.

By using 2 or 3 pump channels and various tubing sizes, a good variety of gradients can be formed.

4.2 NON-LINEAR GRADIENTS

Non-linear gradients are more common than linear gradients because of the diversity of conditions they provide.

Convex gradients are useful where the elution conditions need to change rapidly during the early part of a separation process and more slowly at the end. The is useful for flushing out a few weakly bound species and then separating several more tightly bound species.

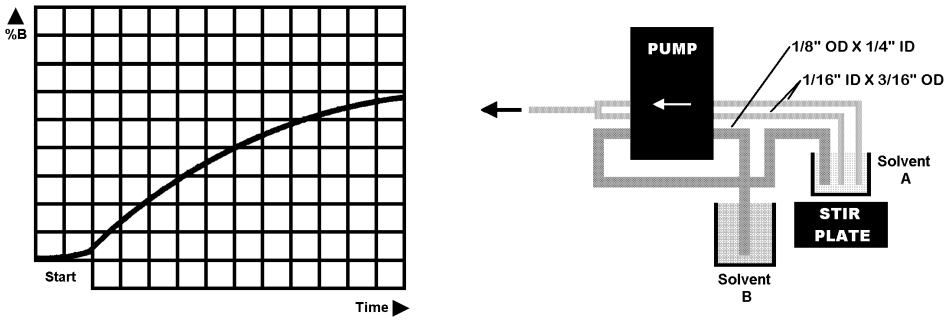

Figure 4-1. Slightly Convex Gradient.

Figure 4-1 shows the experimental setup for a slightly convex gradient. This is the simplest gradient to produce requiring only 2 pump channels and a stirrer. To generate this type of gradient fill the solvent A reservoir with the first (initial) solvent and the solvent B reservoir with the second (final) solvent and begin pumping. The volume in the solvent A reservoir will remain constant since solvent is replaced at the same rate it is removed, but the composition will gradually change toward solvent B. Since the composition only asymptotically approaches pure solvent B, the gradient will never attain a composition of pure solvent B. Since the flows into and out of the solvent A reservoir are the same, the length of the gradient depends solely on the volume of the solvent B reservoir.

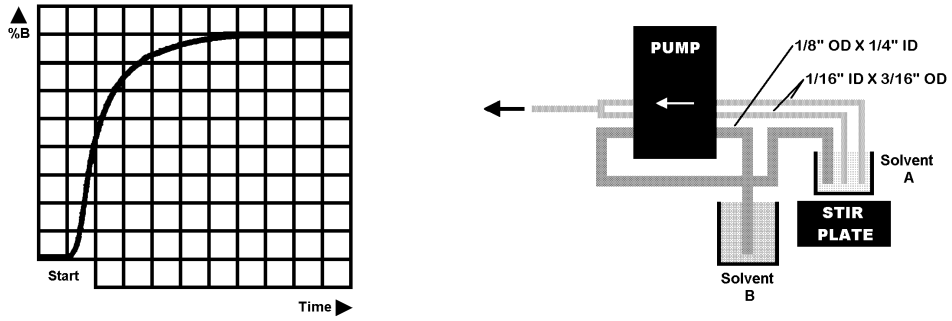

Figure 4-2. Sharper Convex Gradient.

As shown in Figure 4-2, a sharper convex gradient can be made by using 3 pumping channels. To generate this type of gradient, place the appropriate solvents in their containers and start the pump. Here the flow of solvent B into the solvent A container is greater than the flow out of the container, so that the amount of liquid in the solvent A container will gradually increase during the gradient; room must be left for this increase in fluid at the start of the gradient. Since the flow of B into the gradient container is greater than the flow out of the container, the composition changes more rapidly early in the gradient. As in the previous gradient the composition only asymptotically approaches pure solvent B.

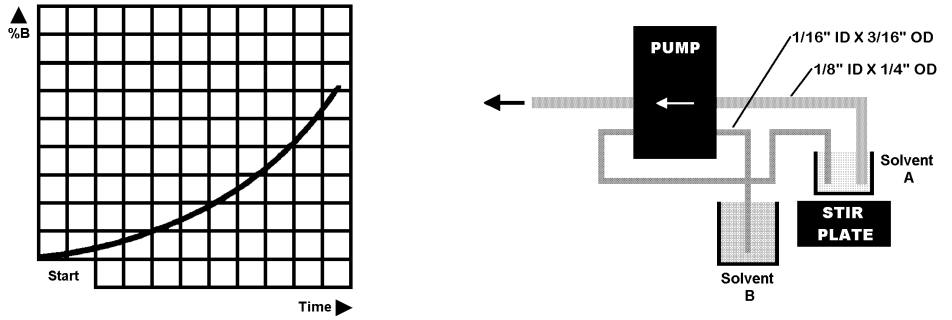

Figure 4-3. Slightly Concave Gradient.

A slightly concave gradient can also be formed using only 2 pump channels, as shown in Figure 4-3. To generate this type of gradient, place the appropriate solvents in their containers and start the pump. Here the flow out of the gradient container is greater than the flow of solvent B into the container so that it will empty during the coarse of the experiment. Since the flow out is greater than the flow in, the gradient must be stopped when the container is nearly empty or you would risk introducing air onto your column. The length of the gradient is limited by the initial volume of solvent A.

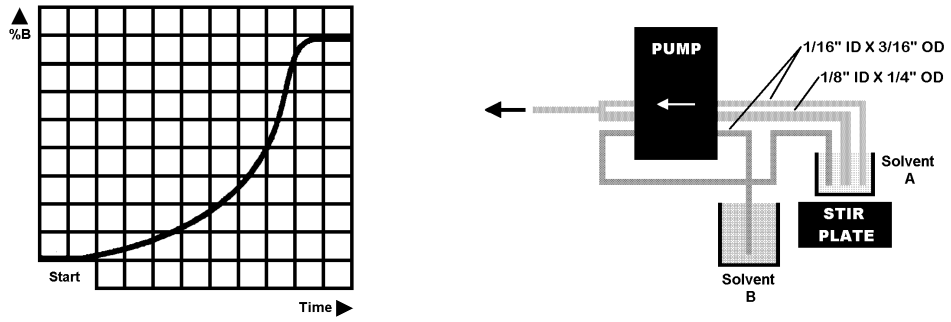

Figure 4-4. Sharper Concave Gradient.

Figure 4-4 shows how a more sharply concave gradient can be made by using 3 pump channels. To generate this type of gradient, place the appropriate solvents in their containers and start the pump. Again, the flow out of the gradient container is greater than the flow of solvent B into it and the gradient container will empty during the coarse of the experiment. Since the flow out is greater than the flow in, the gradient must be stopped when the container is nearly empty or you would risk introducing air onto your column. The length of the gradient is limited by the initial volume of solvent A.

4.3 LINEAR GRADIENTS

A very linear gradient can also be produced by using 3 pumping channels. They should be connected as shown in Figure 4-5. For maximum linearity the 3 tubing pieces should be similar in length and age.

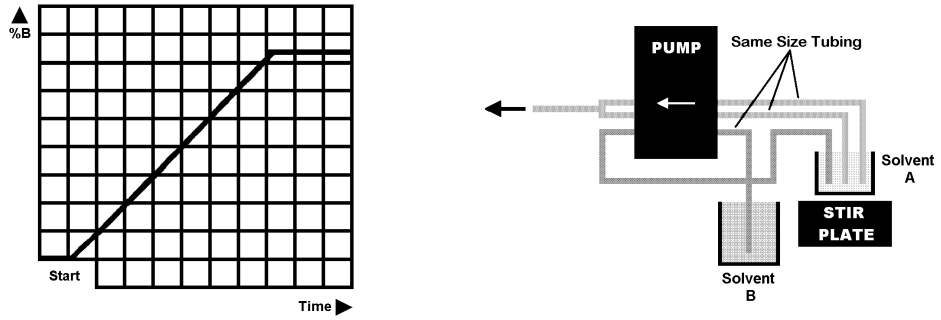

Figure 4-5. Linear Gradient.

In this instance, a volume of solvent A equal to ½ the volume to be pumped should be put in the solvent A reservoir and a volume of solvent B greater than this should be put into the solvent B reservoir. Then prime the pump lines by running the pump until solvent B is just ready to mix with the A. Then resume pumping to generate the gradient. When the solvent A reservoir becomes empty you will have reached the end of the gradient.

5 THEORY OF OPERATION FOR MP-1 PUMP

5.1 ELECTRICAL DESCRIPTION

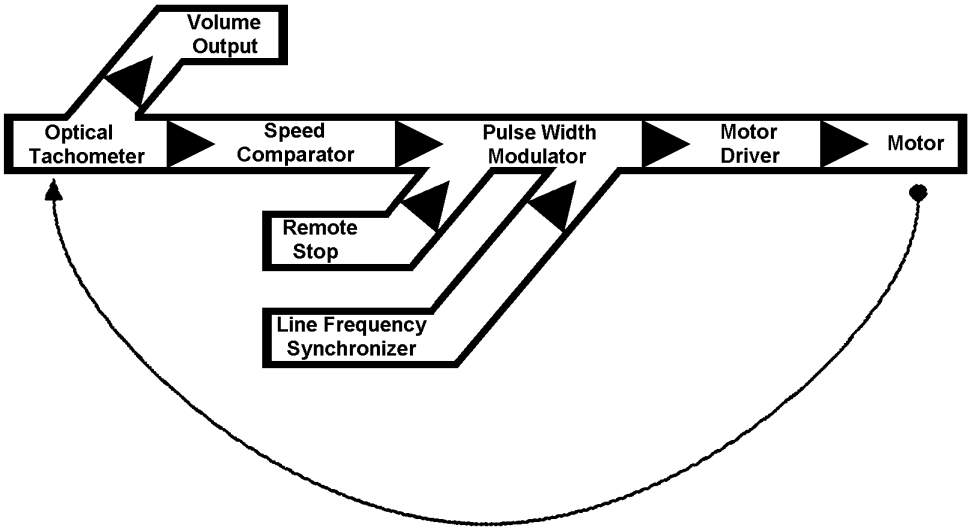

Figure 5-2. MP-1 Electrical Block Diagram

Refer to the electrical schematic diagram, Figure 5-1, and the electrical block diagram, Figure 5-2, as needed when following the circuit descriptions.

To provide the ultimate in motor speed control, an optical tachometer is used to monitor the speed of the pump and provide the negative feedback used in the control loop. The tachometer uses a spoked disc connected directly to the motor shaft to sense the speed. The rate at which the disc turns is sensed by two photodetector/emitter pairs (U1 and U2) which are used to form a quadrature detector allowing greater resolution to be obtained with the use of a high gear reduction DC motor. A voltage proportional to the sensed speed is produced by the first half of U4.

The speed information is also provided to U5 which generates the volumetric outputs for the fraction collector and chart recorder.

The Speed Knob on the front panel, R10, is used to produce a voltage proportional to the desired motor speed. This desired speed voltage is compared to the actual motor speed voltage produced by U4 and the difference used to control a pulse-width modulator, U6.

The pulse width modulator is synchronized to the AC line frequency by U7A. It is also inhibited by applying the remote stop signal. Two diodes (D4 and D7) are used to couple the output of the pulse width modulator to the two SCR drivers for the motor.

Power for the motor is provided by an 18V transformer. The transformer output is rectified by the full-wave bridge rectifier composed of D2, D5, D20, and D21. Since the 2 SCRs driven by the pulse-width modulator supply power to the motor, the pulse-width modulator controls the motor speed. The tachometer feedback from the motor provides for very precise control of the motor speed.

Power for the electronics package is also provided by the 18V transformer. The full-wave bridge rectifier composed of D18, D19, D20, and D21 rectifies the transformer's output and feeds the 9V regulator (U9) which powers all of the electronics.

Cold-room heater R40 provides about 1 watt of heat even when the pump is set to standby. This minimizes internal condensation, even in damp coldrooms.

5.2 MECHANICAL DESCRIPTION

The pump id powered by a 15 watt permanent magnet DC motor.

One end of the commutator shaft directly drives the tachometer used in controlling the motor speed. The other end is coupled to a reducing gear train.

The gear train provides an 80.371:1 reduction to the rotational speed (and a proportional 80.371:1 increase in the torque supplied). This reduction allows the motor to run at a high enough speed to attain a reasonable efficiency.

The gear train is fully enclosed and permanently lubricated. No maintenance is necessary.

The output of the gear train is coupled directly to the pump head. The gear train and motor can provide the torque necessary (up to 1.8 ft-lb or .25 kg-m) to drive 3 peristaltic pump heads.

6 MAINTENANCE PROCEDURES FOR MP-1 PUMP

6.1 INTRODUCTION

The Spectra/Chrom MP-1 Pump requires no routine maintenance. The gear train is sealed and permanently lubricated.

The troubleshooting and service procedures described in this section should only be performed by a qualified instrument service technician. They do not require the use of specialized instrumentation, but the MP-1 Pump can present hazards while its can top is removed.

Additional information on servicing your MP-1 pump can be obtained from the Spectrum Technical Service Department at (800) 459-9700.

6.2 CASE TOP REMOVAL

To remove the case top from the MP-1 Pump, first unplug the pump from the power mains and unplug any cable which may be connected to the remote jack on the read of the pump (item 2 in Figure 1-3). Then simply remove the 5 Phillips head screws from each side of the case top and pull the case top up and off of the pump.

Be careful when the case top is removed. If the pump is connected to the power mains, lethal voltages are present on exposed points on the circuit board, as well as elsewhere in the pump. Lethal voltages are present even with the Power Switch set to standby.

6.3 CALIBRATING THE SPEED

To calibrate the speed sensor of the MP-1 Pump, first remove the case top as described in section 6.2. Be careful after removing the case top since the circuit board presents potentially lethal voltages.

After removing the case top, carefully connect an oscilloscope or frequency counter between pin 10 of U3 (Figure 7-2) and signal common (the anode of D20). Then connect mains power to the pump, set the Power Switch to clockwise, and turn the Speed Knob fully clockwise.

Using an insulated screwdriver or adjustment tool, adjust R9 until the oscilloscope or frequency counter shows that the waveform has a frequency of 2572 Hz.

Switch the pump to standby and disconnect it from the power mains. Disconnect the oscilloscope or frequency counter and replace the case top.

6.4 SERVICE DEPARTMENT

If you have trouble with your MP-1 pump than you cannot resolve, or if you need parts information, contact Spectrum's technical service department at (800) 459-9700 or (281) 443-2900. You may also write to us at:

Spectrum Chromatography
Attn: Service
P.O. Box 672026
Houston, TX 77267

Please contact the service department prior to returning your pump for repair. We may be able to solve your problem with a simple telephone call or mail consultation.

6.5 SHIPPING RETURNS

Remove any pump head from the pump. Shipping a pump drive with a pump head attached will destroy it.

Be sure that all parts and hardware or back in place before packing a return. Wrap the pump in heavy paper or a plastic bag. Put the unit in a strong cardboard box with at least 2 inches of resilient packing material (shredded paper, foam, etc.) on each side of the unit. Seal the package with reinforced tape. Send the unit to the address given by the Technical Service department during your consultation.

It is important the all returns be well packed and insured. Claims for damage due to shipping must be settled between you and the carrier prior to repair.

7 THEORY OF OPERATION FOR MP-2 PUMP

7. 1 ELECTRICAL DESCRIPTION

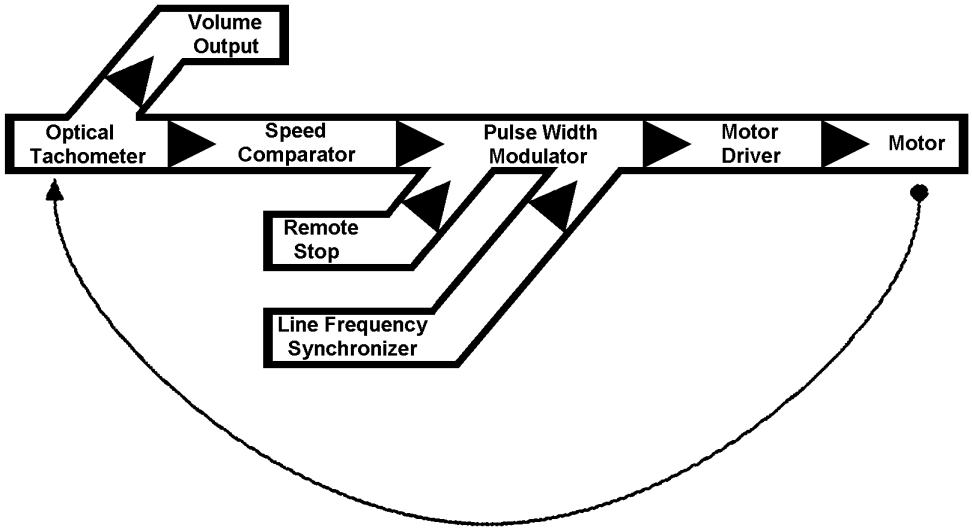

Figure 7-2. MP-2 Electrical Block Diagram

Refer to the electrical block diagram, Figure 7-1, and the electrical block diagram, Figure 7-2, as needed when following the circuit descriptions.

To provide the ultimate in motor speed control, an optical tachometer is used to monitor the speed of the pump and provide the negative feedback used in the control loop. The tachometer uses a spoked disc connected directly to the motor shaft to sense the speed. The rate at which the disc turns is sensed by a photodetector/emitter pairs (U100) and a voltage proportional to the sensed speed is produced by the first half of U3.

The speed information is also provided to U5 which generates the volumetric outputs for the fraction collector and chart recorder.

The Speed Knob on the front panel is used to produce a voltage proportional to the desired motor speed. This desired speed voltage is compared to the actual motor speed voltage produced by U3 and the difference used to control a pulse-width modulator, U6.

The pulse width modulator is synchronized to the AC line frequency by U4A. It is also inhibited by applying the remote stop signal. Two optical isolators are used to couple the output of the pulse width modulator to the two SCR drivers for the motor.

The motor in the pump is powered directly from the AC line. In the 115V version the motor is driven by a full-wave rectifier composed of D2, D6, D15, and D16; in the 230V version the motor is driven by a half-wave rectifier composed of these same components.

Since the 2 SCRs driven by the pulse-width modulator supply power to the motor, the pulse-width modulator controls the motor speed. The tachometer feedback from the motor provides for very precise control of the motor speed.

7.2 MECHANICAL DESCRIPTION

The pump is powered by a 150 watt (0.2 hp) permanent magnet DC motor.

One end of the commutator shaft directly drives the tachometer used in controlling the motor speed. The other end is coupled to a reducing gear train.

The gear train provides an 5.846:1 reduction to the rotational speed (and a proportional 5.846:1 increase in the torque supplied). This reduction allows the motor to run at a high enough speed to attain a reasonable efficiency.

The gear train is fully enclosed and permanently lubricated. No maintenance is necessary.

The output of the gear train is coupled directly to the pump head. The gear train and motor can provide the torque necessary (up to 1.8 ft-lb or .25 kg-m) to drive 3 peristaltic pump heads.

8 MAINTENANCE PROCEDURES FOR MP-2 PUMP

8.1 INTRODUCTION

The Spectra/Chrom MP-2 Pump requires no routine maintenance. The gear train is sealed and permanently lubricated.

The troubleshooting and service procedures described in this section should only be performed by a qualified instrument service technician. They do not require the use of specialized instrumentation, but the MP-2 Pump can present hazards while its can top is removed.

Additional information on servicing your MP-1 pump can be obtained from the Spectrum Technical Service Department at (800) 459-9700.

8.2 CASE TOP REMOVAL

To remove the case top from the MP-2 Pump, first unplug the pump from the power mains and unplug any cable which may be connected to the remote jack on the read of the pump (item 2 in Figure 1-3). Then simply remove the 5 Phillips head screws from each side of the case top and pull the case top up and off of the pump.

Be careful when the case top is removed. If the pump is connected to the power mains, lethal voltages are present on exposed points on the circuit board, as well as elsewhere in the pump. Lethal voltages are present even with the Power Switch set to standby.

8.3 REPLACING BRUSHES

The brushes used in the MP-2 Pump drive have a rated life of 2000 hours. We recommend check the brushes every 1000 hours of use.

To check the brushes, first remove the case top as described in Section 8.2 Be sure that the pump is unplugged.

Lay the pump on its side. Each side of the motor will have an access port for the brushes. Use a slotted blade screwdriver to unscrew the covers and remove the brushes. The brushes should be replaced as a pair whenever either is less than 5” (12.7 cm) in length.

After examining the brushes, if they do not need replacement put them back into the access ports with the same orientation which they had when you removed them and then replace the access port covers.

8.4 CALIBRATING THE SPEED

To calibrate the speed sensor of the MP-2 Pump, first remove the case top as described in section 8.2. Be careful after removing the case top since the circuit board presents potentially lethal voltages.

After removing the case top, carefully connect an oscilloscope or frequency counter between pin 10 of U3 (Figure 7-2) and signal common (the anode of D20). Then connect mains power to the pump, set the Power Switch to clockwise, and turn the Speed Knob fully clockwise.

Using an insulated screwdriver or adjustment tool, adjust R9 until the oscilloscope or frequency counter shows that the waveform has a frequency of 3215 Hz.

Switch the pump to standby and disconnect it from the power mains. Disconnect the oscilloscope or frequency counter and replace the case top.

8.5 SERVICE DEPARTMENT

If you have trouble with your MP-2 pump than you cannot resolve, or if you need parts information, contact Spectrum's technical service department at (800) 459-9700 or (281) 443-2900. You may also write to us at:

Spectrum Chromatography
Attn: Service
P.O. Box 672026
Houston, TX 77267

Please contact the service department prior to returning your pump for repair. We may be able to solve your problem with a simple telephone call or mail consultation.

8.6 SHIPPING RETURNS

Remove any pump head from the pump. Shipping a pump drive with a pump head attached will destroy it.

Be sure that all parts and hardware or back in place before packing a return. Wrap the pump in heavy paper or a plastic bag. Put the unit in a strong cardboard box with at least 2 inches of resilient packing material (shredded paper, foam, etc.) on each side of the unit. Seal the package with reinforced tape. Send the unit to the address given by the Technical Service department during your consultation.

It is important the all returns be well packed and insured. Claims for damage due to shipping must be settled between you and the carrier prior to repair.

9 ORDERING INFORMATION

Part No.	Description
124868	MP-1 Pump drive, 115V
124869	MP-1 Pump drive, 230V
146821	MP-2 Pump drive, 115V
146822	MP-2 Pump drive, 230V
146924	Fast-Load Pump Head, size 13-18 tubing
146809	Standard pump head for size 13 tubing
123732	Size 13 Silicone tubing, 3m length, 5/32” OD x 1/32” ID
123734	Size 13 Silicone tubing, 15m length, 5/32” OD x 1/32” ID
123736	Size 13 LPF tubing, 3m length, 5/32” OD x 1/32” ID
146811	Standard pump head for size 14 tubing
123746	Size 14 Silicone tubing, 3m length, 3/16” OD x 1/16” ID
123748	Size 14 Silicone tubing, 15m length, 3/16” OD x 1/16” ID
123750	Size 14 LPF tubing, 3m length, 3/16” OD x 1/16” ID
146813	Standard pump head for size 16 tubing
123760	Size 16 Silicone tubing, 3m length, 1/4” OD x 1/18” ID
123762	Size 16 Silicone tubing, 15m length, 1/4” OD x 1/18” ID
123764	Size 16 LPF tubing, 3m length, 1/4” OD x 1/18” ID
146817	Standard pump head for size 17 tubing
123856	Size 17 Silicone tubing, 3m length, 3/8” OD x 1/4” ID
123858	Size 17 Silicone tubing, 15m length, 3/8” OD x 1/4” ID
123860	Size 17 LPF tubing, 3m length, 3/8” OD x 1/4” ID
146819	Standard pump head for size 18 tubing
123788	Size 18 Silicone tubing, 3m length, 7/16” OD x 5/16” ID
123790	Size 18 Silicone tubing, 15m length, 7/16” OD x 5/16” ID
123792	Size 18 LPF tubing, 3m length, 7/16” OD x 5/16” ID