Precision Syringe & Peristaltic Pumps

Pump 11 Pico Plus, see page A9

PHD 22/2000 Advanced Syringe Pumps, see pages A12 to A15

PHD 22/2000 Hpsi (High Volume & Pressure), see page A16

MPII Mini-Peristaltic Pump, see page A42

4 and 8-Channel Microprocessor Controlled Tubing Pumps, see page A52

Pump Selection Guide

Choosing the Right Pump for Your Application and Budget

Harvard Apparatus - Setting the Standards in Pumping Technology

Harvard Apparatus offers a broad selection of syringe, peristaltic and continuous flow pumps to suit almost every application. Syringe pump models have been expanded to include new innovative pumps with the widest range of flow rates and forces of any manufacturer. The following guide and tables were designed to answer most questions regarding syringe and peristaltic pumps. Please review the following pages then contact our customer service department for further assistance, if needed.

Harvard Apparatus has a long history of inventing, innovating and manufacturing syringe pumps. Harvard Apparatus invented the lead screw based syringe pump in the 1950's and introduced the first microprocessor pump, the now legendary Pump 22, in the 1980's. Our syringe pumps are so accurate, even at low flow rates, that they have become the standard for mass spectrometry calibration and anywhere accurate volumes must be delivered. The innovations continue with recent additions to the PHD 22/2000 programmable pump line with enormous pressure and flow capability; the New 11 Plus, the standard for general laboratory experiments; the New Pump 11 Pico Plus for picoliter and small volume injections; an entire new selection of peristaltic pumps; an expanded line of component pumping modules for the OEM and do-it-yourself markets, and much, much more.

We are frequently asked to assist in the selection of the appropriate pump for a variety of research applications. The following list was developed as a guide to help you quickly and easily choose the right pump for your application. Consider the following questions when selecting your pump. If your specifications do not appear to be met by these pumps, please call our customer service department for further assistance.

1. Pump Types: Advantages and Disadvantages

SYRINGE PUMP

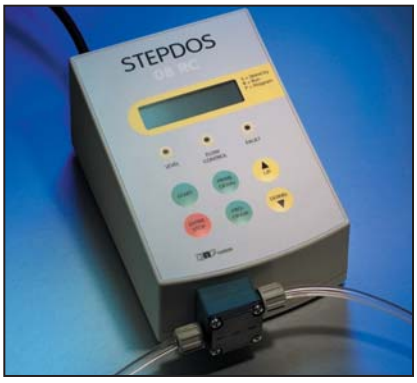
(PHD 22/2000 Programmable Shown)

Syringe pumps provide the most accurate delivery of fluids. They use a syringe for the fluid reservoir. The syringe pump motor moves the pusher block forward which depresses the syringe plunger causing the dispensing of fluid. See pages A8 to A36.

PERISTALTIC PUMP

(MPII Mini-Peristaltic Shown)

Peristaltic pumps dispense fluid using a rotating head mechanism. The rotating head has a number of rollers that depress the tubing driving the fluid forward. These pumps have and external reservoir and therefore can accommodate a much larger volume of fluid. See pages A41 to A69.



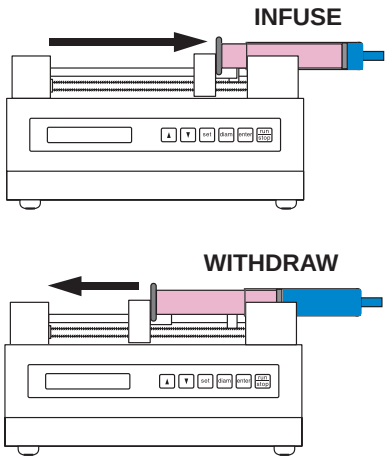
DIAPHRAGM PUMP

(STEPDOS Liquid Metering Shown)

These pumps use a pulsating diaphragm to move fluid. They are ideal for pumping suspensions of particles. See page A91.

1. Pump Types: Advantages and Disadvantages (Continued)

SYRINGE PUMPS



A motor driven threaded rod (lead screw) slowly turns, moving the plunger of the syringe in, and pushing the fluid out. Reversing the direction of the motor allows for withdrawal of fluids.

ADVANTAGES

- Works at pressures up to 3000 psi
- Highest precision < 0.1%
- Pulse free flow
- Accurately dispense very small to large volumes < ± 0.35
- Easily sterilizable
- Can dispense or withdraw
- Many easily programmable dispensing profiles: gradients
- 1 to 10 channels of operation

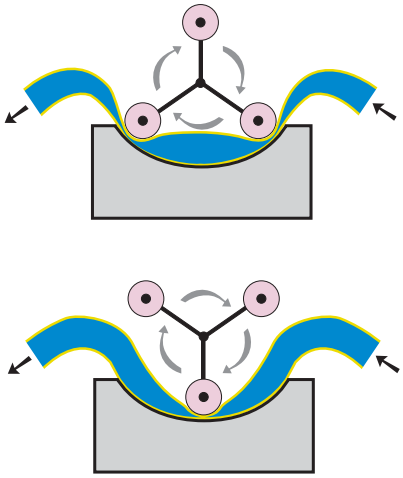
DISADVANTAGES

- Pumps finite volumes
- Slightly more expensive

TYPICAL APPLICATIONS

- Pumping sample/ calibrant into Mass Spectrometer
- Accurate dispensing of drugs in animals
- High pressure flow into reaction chamber

PERISTALTIC PUMPS



In this example three rollers on rotating arms pinch the tube against an arc and push the fluid along. There are usually three or four sets of rollers.

ADVANTAGES

- Pumps continuous volumes
- Sterilizable
- Less expensive for multiple channel dispensing
- 1 to 16 channels of operation
- Can dispense or withdraw

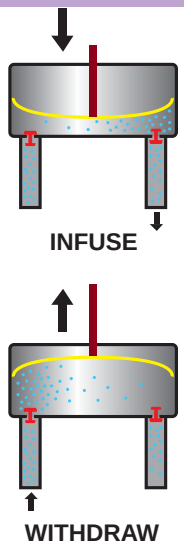
DISADVANTAGES

- Low pressure operation, 30 psi or less
- Pulsing flow
- Moderate precision 1 to 3%

TYPICAL APPLICATIONS

- Perfusion flow across tissue or cells
- Pump in and out with balanced flow
- Transfer bulk liquids ie. controlled animal feeding

DIAPHRAGM PUMPS



The red rod shown in this drawing is moved by a motor or solenoid. It pushes the diaphragm in and a spring forces it back out.

ADVANTAGES

- Very low maintenance
- Can pump suspensions of particles
- Can pump aggressive/corrosive solutions
- Self priming

DISADVANTAGES

- Single channel operation
- Pulsing flow
- Moderate precision 2%
- Can only dispense
- Difficult to sterilize

TYPICAL APPLICATIONS

- Pumping highly corrosive materials

2. Pump Application Guide

Find your application and go to the pages indicated for more information

Typical Applications	Syringe Pump	Peristaltic Pump	Diaphragm Pump	PRODUCT SELECTION (page #)
Instrument Injection				
ACCURATE AND PRECISE TRANSFER OF LIQUIDS BETWEEN CONTAINERS	•			PHD 22/2000 (A12) or Pump 22 (A10)
INJECT SAMPLE OR CALIBRANT INTO MASS SPECTROMETER	•			PHD 22/2000 (A12) (smoothest delivery 0.08 µm steps); Pump 11 Plus (0.3 µm steps) (A8) or 11 Pico Plus (A9)
Drug Delivery				
ACCURATE <1%, PRECISE <0.1% SAME RATE OF INFUSION OF DRUGS INTO ANIMALS	•			PHD 22/2000 (A12); Pump 33 (A11); Pump 22 (A10); Pump 11 Plus (A8); Harvard 1 (A23)
ACCURATE <1% AND PRECISE <0.1% DIFFERENT RATES OF INFUSION OF DRUGS INTO ANIMALS	•			Pump 33 (A11) Harvard 1 (A23)
BATTERY OPERATION AND OCCLUSION DETECTION	•			Harvard 1 (A23)
TIMED DELIVERY OF DRUGS INTO ANIMALS	•			PHD 4400 Hpsi; PHD Programmable (A18)
High Pressure Injection				
HIGH SPEED, HIGH PRESSURE BETWEEN 30 AND 1500 PSI INJECTION INTO REATION CHAMBERS	•			PHD 4400 Hpsi (A18); PHD 22/2000 Hpsi (A16); PHD 22/2000 (A12)
INJECTION OF FLUIDS INTO HIGH BACKPRESSURE VESSELS BETWEEN 30 AND 1500 PSI	•			PHD 4400 Hpsi (A18); PHD 22/2000 Hpsi (A16)
Fluid Blending				
GMP AND VALIDATED DISPENSING FOR PHARMACEUTICAL AND BIOTECHNOLOGY APPLICATIONS	•			PHD 22/2000 (A12); PHD 4400 Hpsi (A18); Pump 22 (A10)
ACCURATE BLENDING OF SOLUTIONS FOR TITRATION	•			PHD 4400 Hpsi; PHD Programmable (A18)
A SINGLE PUMP UNIT WITH TWO INDEPENDENT CHANNELS OF OPERATION AND CONTINUOUS FLOW	•			Pump 33 (A11)
PC SOFTWARE CONTROLLED SYRINGE PUMP	•			PHD 22/2000 (A12); PHD 4400 Hpsi (A18); Pump 33 (A11); Pump 22 (A10); Symphony Windows™ Pump Manager (A17)
Animal Feeding				
ACURATE FEEDING OF 1 TO 10 ANIMALS SIMULTANEOUSLY	•			PHD 22/2000 (A12); PHD 4400 Hpsi (A18); Pump 22 (A10)
BULK TRANSFER OF FLUIDS FROM CONTAINER TO CONTAINER		•		66/77 (A43); TPM (A64) DPM (A65)
NON-ACCURATE FEEDING OF 1 TO 16 ANIMALS SIMULTANEOUSLY		•		TPM (A64); MPL (A66) 1200
Perfusions				
PERFUSING LIQUIDS ACROSS CELLS OR TISSUES		•		MPII (A42); 720 (A42); 66/77 (A43)
PERFUSING LIQUIDS WITH SIMULTANEOUS BALANCED WITHDRAWAL OF FLUIDS	•	•		PHD Push/Pull Syringe Pump (A12)
Highly Corrosive				
A SINGLE CHANNEL OF CONTINUOUS PUMPING OF HIGHLY CORROSIVE FLUIDS			•	StepDos Liquid Metering (A91)
STAINLESS STEEL SYRINGE PUMPS	•			PHD 22/2000 Hpsi (A16); or PHD 4400 Hpsi (A18)
Blood Pumps				
PULSATILE, SIMULATES THE HEART ACTION				Pulsatile Blood Pump (A37)
OEM Fluid Handling Products and Custom Products	•	•		

3. Pump Configuration Guide

Answer questions, then call Technical Support if you require additional assistance

	PUMP TYPE	Syringe	Peristaltic	Diaphragm
1	**SELECT THE TYPE OF PUMPING THAT IS BEST SUITED FOR YOUR APPLICATION**			
2	**SELECT THE MODES OF OPERATION YOU WANT THE PUMP TO HAVE**			
2a	Do you want to dispense and /or withdraw?	1) **PUSH** - infuse or infuse/ withdraw (discontinuous) 2) **PUSH/ PULL** - infuse /withdraw (continuous flow or discontinuous flow); simultaneous infuse and withdraw; continuous flow	1) **FORWARD / REVERSE** infuse/withdraw (continuous flow or discontinuous flow); simultaneous infuse and withdraw; continuous flow	1) **INJECT** - infuse (continuous flow)
2b	Do you need disposable wetted surfaces?	Disposable syringes	Disposable tubes	Diaphram is not easily replaceable, and difficult to clean
2c	Is chemical compatibility with wetted parts an issue?	Many choices of materials from glass, plastic, stainless steel, excellent chemical resistance	Different tubing types, very versatile, more difficult to get high chemical resistivity	Very Durable and extremely high chemical resistivity
3	**WHAT DELIVERY, FLOW RATE, PUMPING SPEEDS DO YOU REQUIRE?**			
3a	What flow rates do you require (units)?	picoliters to milliliters	milliliters to liters	milliliters
3b	Do you want to dispense an unlimited, continuous stream? (pg. 331 for heated fluids)	This is an optional function if volume exceeds syringe size, requires additional valves	This is standard, external reservoir sets limit on volume	This is standard, external reservoir sets limit on volume
4	**NUMBER OF FLOW STREAMS YOU WANT AVAILABLE**			
4a	# of fluids do you want to deliver - **least**	1	1	1
4b	# of fluids do you want to deliver - **most**	>10	16	1
5	**TOTAL AMOUNT OF FLUID YOU NEED TO DISPENSE DURING YOUR EXPERIMENT (SYRINGE SIZE)**			
5a	Will you dispense an accurate volume and repeat same volume over and over?	excellent	good	good
6	**FLUID PRESSURE REQUIREMENT - IF YOU ARE NOT SURE, USE THE PRESSURE CALCULATOR, see page A92**			
	Maximum pressure requirement	2000 psi	15 psi - 25 psi	30 psi
7	**FLOW CHARACTERISTICS AND SPECIFICATIONS**			
7a	Accuracy and precision required	Most accurate (±0.35%) and most precise (±0.05%)	Good to poor accuracy (±2.0 to 0.5%) & precision (±10.0 to 1.0%)	Good to poor accuracy (±2%) and precision (±2%)
7b	Do you need pulseless flow?	Virtually pulseless	Medium to heavy pulsing	Medium to heavy pulsing
8	**PROGRAMMABILITY : (PC or Microprocessor Self contained in pump or Strictly mechanical control at pump)**			
8a	Type of user interface	Microprocessor / Mechanical	Microprocessor / Mechanical	Microprocessor
	Gradient mixing (2 Pumps)	yes / no	no / no	no
	Multiple dispense w/ external trigger; by volume; by time	yes / no	no / no	no
	Infuse/withdraw in/out of the same program	yes / no	no / no	no
8b	Easy-to-use (+ + + + = the best)	+ + + + / + +	+ + + + / + +	+ + +
8c	Remote control	option / option	option / option	option
8d	Computer control	included or option	included or option	included or option
8e	Programmability	yes / no	yes / no	no
9	**COMMUNICATION AND AUTOMATIC CONTROL**			
	Type user interface	Microprocessor / Mechanical	Microprocessor / Mechanical	Microprocessor
	RS-232 connections	May be option or included	May be option or included	yes
	TTL triggers	May be option or included	May be option or included	yes
	Time control of dispense through keyboard	yes / no	yes / no	yes
	PC control software	yes / no	yes / no	no
10	**IS RUNNING WITH MINIMAL MAINTENANCE IMPORTANT TO YOU**			
10a	Reliability	Extremely high - 2 year warranty	Good - 1 year warranty	Extremely high - 1 year warranty

Pump Selection Guide

4. Syringe Pump Comparison Guide

Features & Specifications	GENERAL PURPOSE SYRINGE PUMPS				
Harvard Syringe Pump Model	Pump 11 Plus	Pump 11 Pico Plus	Pump 22	Pump 33	PHD 22/2000
FLOW DIRECTION					
Infusion Only	X		X		X
Infuse or Withdraw (I/W)	Option	X	X	X	X
I/W with Independent Channel Control				X	
Push/Pull (Simultaneously I/W)				X	
PRESSURE					
Linear Force (Pounds)	16	25+	47	57	50
PSI Range (Syringe Dependent)	Refer to Pressure / Syringe Chart, see page A93				
ADVANCED SELF-PROGRAMING					
Gradient Mixing (2 Pumps)					X
Multiple Dispense with External Trigger; By Volume; By Time					X
Infuse/Withdraw In/Out of the Same Program					X
Valve Control			X	X	X
Foot & Timer Control			X	X	X
Outputs to Scales And Printers					X
FLOW RATE RANGE					
Minimum	0.0014 µl/hr	3.3333 pl/min	0.002 µl/hr	0.0004 µl/hr	0.0001 µl/hr
Maximum	26.56 ml/min	0.4394 ml/min	55.1 ml/min	106.6 ml/min	220.82 ml/min
Accurracy %	±0.5	±0.5	±0.35	±0.35	±0.35
Reproducibility %	±0.1	±0.1	±0.1	±0.1	±0.05
End of Travel Switch	X	X		X	
Stall Detection			X	X	X
# SYRINGES IN HOLDER & SIZE RANGE					
Single Syringe Rack	0.5 µl to 60 ml	NA		0.5 µl to 140 ml	
Dual Syringe Rack	0.5 µl to 10 ml	0.5 µl to 10 ml	0.5 µl to 140 ml		0.5 µl to 140 ml
Microliter Syringe Rack, 4 Syringe			0.5 µl to 10 ml		0.5 µl to 10 ml
6/10 Syringe Rack			0.5 µl to 60 ml		0.5 µl to 60 ml
4 x 140 ml Syringe Rack Plastic Syringes			50 ml & l40 ml		50 ml & l40 ml
Rack Can Hold HAI Stainless Steel Syringes			8 ml to 100 ml	8 ml to 100 ml	8 ml to 100 ml
OTHER FEATURES					
Display	VFD	VFD	LED	LED	VFD
Rate Dispense	X	X	X	X	X
Volume Dispense	X	X			X
Anti-Syphoning	X	X	X	X	X
Computer Control-RS-232	Advanced Model Only	X	X	X	X
TTL Control				X	X
Remote Mechanical Unit (120 Feet)					X
Occlusion Pressure Detect					
Battery Power Back-Up					
WARRANTY	2 Year	2 Year	2 Year	2 Year	2 Year
ORDERING INFORMATION					
Base Price					
see page	A8	A9	A10	A11	A12 to A15

Syringe Pump Comparison Guide

			SPECIALTY PUMPS			STANDARD PUMPING MODULES		
PHD 22/2000 PUSH PULL	PHD 22/2000 Hpsi (4 syringe)	PHD 4400 Hpsi	Harvard 1	Pulsatile Blood Pump	10 Syringe Feeding Station	Microliter Flow	Milliliter Flow	High Pressure
	X	X	X	X	X			
	X	X			X	X	X	X
X								
50	433	200	10	25	433	6	16	200
X	X	X			X			
X	X	X						
X	X	X						
X	X	X						
X	X	X						
X	X	X						
0.0001 µl/hr	1.5 µl/hr	0.0001 µl/hr	0.01 ml/hr	0.05 ml	1.5 µl/hr	0.0014 µl/hr	0.0014 µl/hr	0.0001 µl/hr
220.82 ml/min	112 ml/min	220.82 ml/min	20 ml/min	100 ml	112 ml/min	0.854 ml/min	26.56 ml/min	220.82 ml/min
±0.35	±0.5	±0.35	±3.0	±2.0	±0.35	±0.5	±0.5	±0.5
±0.05	±0.05	±0.05	±0.1	±0.5	±0.5	±0.1	±0.1	±0.1
			X			X		
X	X	X	X		X		X	X
		0.5 µl to 140 ml	1 ml to 60 ml			0.5 µl to 1.0 ml	0.5 µl to 60 ml	0.5 µl to 140 ml
0.5 µl to 60 ml								
0.5 µl to 60ml								
	20 ml to 200 ml	8 ml to 100 ml						
VFD	VFD	VFD	GRAPHIC	LED	VFD			
X	X	X	X		X			
X	X	X	X		X			
X	X	X	X	X	X	X	X	X
X	X	X			X			
X	X	X			X			
X	X	X			X			
			X					
			X					
2 Year	2 Year	2 Year			2 Year	2 Year	2 Year	2 Year
A12 to A15	A16	A18	A23	A37	A32	A33	A36	A34

Precision Syringe Pumps

NEW Pump 11 Plus

- NEW brighter display: easier to read and use
- NEW volume dispense feature
- Single or dual syringe models available
- Small, compact size
- Legendary reliability – 2 year warranty

Harvard Apparatus' Syringe Pump 11 Plus combines smoother flow and updated features to create a high performance syringe pump with a basic syringe pump price!

Bright Display and Easy-To-Use Interface

A new, two-line 16 character vacuum fluorescent display and six membrane keys make this a powerful, easy-to-use syringe pump. Only two entries are required to start pumping; Syringe ID and flow rate. The flow rate can be changed while the pump is running.

Two Modes of Operation, Constant Flow Rate & Volume Dispense

The new Pump 11 Plus will operate continuously in RATE mode or accurately dispense a specific amount of fluid in VOLUME mode.

Versatile

Select from two different models. The standard Pump 11 Plus model has the following features:

- Infusion Only
- End of Travel Limit Stop
- Anti-Siphon Bracket

The Pump 11 Plus Advanced model has the same features as the standard model, but also includes:

- Infusion/Withdrawal
- Dual RS-232 Communications

Both models are available with either a single syringe configuration or dual syringe configuration. Select the pump that best fits your application.

Non-Volatile Memory

New micro-stepping pump profiles deliver very smooth and consistent flow over the entire flow rate range. These pumps now feature non-volatile memory. The pump remembers its last syringe size, flow rate used and configuration settings. An advanced universal power supply means there is no need to change AC line switches, fuses or wires. The new Pump 11 Plus will operate on any AC line voltage from 95 VAC to 240 VAC, either 50 or 60 Hz. The new Pump 11 Plus offers the same power failure mode as our PHD 22/2000 syringe pump series. In a power failure the pump can either Resume or Stop pumping when power is returned.

Safety

The Pump 11 Plus motor will not shut itself off in case of overload, rather it will remain in a stalled position with no damage. An adjustment collar on the guide rod prevents the syringe plunger from hitting bottom.

CE Mark Approved

The new Pump 11 Plus meets all relevant European EMC and Safety requirements for laboratory equipment..

Specifications

Type	Microprocessor single or dual syringe, infusion only or infuse/withdraw
Accuracy	±0.5%
Reproducibility	±0.1%
Syringes Size:	Single/Dual
Minimum	0.5 µl/0.5 µl
Maximum	50/60ml/10ml
Flow Rate:	
Minimum	0.0014 µl/hr
Maximum	26.56 ml/min
Non Volatile Memory	Storage of all settings
RS-232	Option
TTL	No
Average Linear Force	16 lbs
Drive Motor	0.9° micro step angle motor
Motor Drive Control	1/4 microstepping
Motor Step per One Rev. of Lead Screw	3200 at 1/4 stepping
Resolution	0.33 µm/step
Step Rate:	
Minimum	6.8 sec/step
Maximum	416.7 µsec/step
Pusher Travel Rate:	
Minimum	2.9068 µm/min
Maximum	47.6 mm/min
Input Power	12 VDC 1.5 Amps
Voltage Range (Power Supply)	Universal input 100/250 VAC, 50/60 Hz, 18 watts (Use only Harvard Apparatus approved supply and line cord)
Dimensions, H x W x D	13 x 22.9 x 11.4 cm (5 x 9 x 4.5 in)
Weight	2.1 kg (4.6 lb)

** Actual force is higher. Not recommended for applications with more than 25 lbs of force.*

Catalog No.	$	Product
BS4 70-2208		Harvard Pump 11 Plus Single Syringe
BS4 70-2209		Harvard Pump 11 Plus Dual Syringe
BS4 70-2211		Harvard Pump 11 Plus Advanced Single Syringe with Dual RS-232
BS4 70-2212		Harvard Pump 11 Plus Advanced Dual Syringe with Dual RS-232

NEW Pump 11 Pico Plus

BS4 70-2213 Pump 11 Pico Plus

An accessory pack is available for this pump. It contains 26 gauge blunt needles, fused silica connecting tube and connecting adaptors.

Specifications

Pump Type	Dual syringe infusion/withdraw
Accuracy	±0.5%
Reproducibility	±0.1%
Syringes:	
Holder	Dual
Type	Plastic or glass
Size Minimum	0.5 µl
Size Maximum	10 ml
Flow Rate:	
Minimum	3.3 pl/min (using 1 µl syringe)
Maximum	0.4394 ml/min (using 2 x 10 ml syringes combined output)
Non Volatile Memory	Storage of all settings
RS-232 Communication	Yes
Average Linear Force	25 lbs*
Drive Motor	1.8 step angle geared 36:1 motor
Motor Drive Control	1/4 microstepping - Full stepping
Motor Step per One 3200 at 1/4 stepping	14,400 steps /rev of the leadscrew
Resolution	0.0184 µm/step
Step Rate:	
Minimum	1 pulse in 27.6 sec
Maximum	200 steps/sec
Pusher Travel Rate:	
Minimum	0.0388 µm/min
Maximum	0.8333 mm/min
Input Power	12 VDC 1.5 Amps
Voltage Range (Power Supply)	Universal input 100/250 VAC, 50/60 Hz, 18 watts (Use only Harvard Apparatus approved supply and line cord)
Dimensions, H x W x D	11.4 x 22.9 x 11.4 cm (4.5 x 9 x 4.5 in)
Weight	2.3 kg (5 lbs)

** Actual force is higher. Not recommended for applications more than 25 lbs of force.*

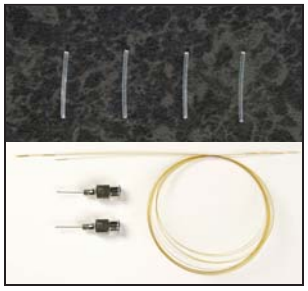
Applications

- Cellular injection i.e. oocytes
- Micro flow for FIA or capillary LC
- Micro reaction delivery

Features

- Infuse/ withdraw capability
- Dual syringes for broad flow rate range
- Easy-to-read display, the injection rate can be changed from 0.0550 pl/sec to 0.0073 ml/sec
- Remote to micromanipulator injections are easy non-obstructed viewing and no heavy weight to hinder positioning
- This pump has exceptional milliliter, microliter, nanoliter and picoliter smooth and accurate flow, easily set through the keyboard
- The injection can be controlled by initiating the manual start button, RS-232 through your computer or with the included foot pedal
- Operating parameters are set with the membrane keypad and VFD display
- From the keypad the user can set pump to:
  - Infusion mode
  - Withdrawal mode (reversing switch on back panel)
- All micro tubing and connectors are available
- Volume mode - enter a target volume, pump will stop when value achieved
- Adjustable infusion limit switch and adjustable withdraw mechanical stop
- Legendary reliability – 2 year warranty

BS4 55-4144 Foot Switch



BS4 72-2214 Accessory Pack

Catalog No.	$	Product
BS4 70-2213		Pump 11 Pico Plus
BS4 70-2214		Accessory Pack for Pump 11 Pico Plus. Contains one each of BS4 72-4684 and BS4 59-7627 and two BS4 59-7624
BS4 72-4684		26 Gauge Blunt Tip Needle, 1/2 in, pkg. of 2 (OD = 0.018 in, 0.457mm)
BS4 59-7627		Adaptor 250 µm PE, pkg. of 4 OD = 0.76mm (0.030 in) ID = 0.25 mm (0.010 in)
BS4 59-7624		Connecting Tubing Fused Silica, 100 cm

For 1700 Series of GASTIGHT®, see page A73.
For 1000 Series of GASTIGHT®, see page A74.

Pump 22 Multiple Syringe Pump

- Legendary reliability – 2 year warranty
- Versatile
- Easy to use
- Nonvolatile memory
- Sturdy construction
- Computer control

The Harvard 22 syringe pump is the pump that set the industry standard! It is the world's most popular syringe pump. Harvard Apparatus' long-standing tradition of providing rugged and reliable products is the foundation upon which this pump was built.

Since the introduction of the first pump 22 many features and innovations have been added to the pump to offer a complete line of pumps for multiple syringe applications. Versions of the pump 22 for 4 microliter syringes, a 10 syringe rack and a syringe rack for 1 to 4, 140 ml syringes are available. An anti-siphon model is also available for infusion applications where the line pressure is lower than the syringe pressure. The anti-siphon bracket securely retains the syringe plunger to prevent unintended loss of fluid from the syringe.

This pump features an LED display and numerical keypad for easy entry of syringe diameter data and flow rates. Flow rate units can be set in µl/hr, µl/min, ml/hr and ml/min. An optical encoder monitors lead screw rotation to accurately maintain any flow rate. The run LED flashes when syringe plunger movement stops unexpectedly. A complete line of accessories for the Pump 22 are available including an interface box to make the connection of multiple accessories to a single pump fast and easy, see page A19.

The pump 22 can be controlled using RS-232 (serial) commands. An interface box and computer connector are required, see page A19 for a complete list of pump accessories. Multiple syringe pumps can be interconnected by daisy chaining pumps. Up to 100 pumps can be addressed independently using internal reference addresses from 0 to 99. A set of sample programs, using the Basic programming language, is included with each pump.

For Symphony Software, see page A17.

For Accessories, see page A19.

For GASTIGHT® Syringes, see pages A73 and A74.

For Plastic Syringes, see pages A76 and A77.

For Stainless Steel Syringe, see page A70.

For Tubing, see pages A78 to A87.

For Luer Connectors and Kits, see pages A88 to A91.

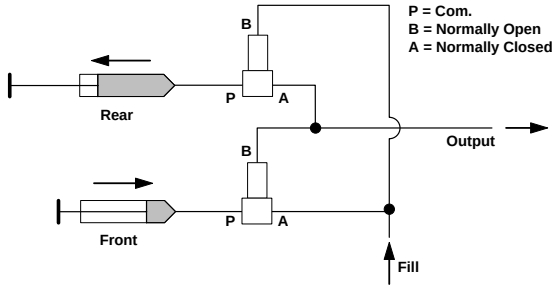
Specifications

Type	Microprocessor multiple syringe, infusion or infusion/withdrawal
Accuracy	±0.35%
Reproducibility	±0.05%
Syringes Size:	
Minimum	0.5 µl
Minimum	140 ml
Flow Rate:	
Minimum	0.002 µl/hr
Maximum	55.1 ml/min
Non Volatile Memory	Storage of all settings
RS-232	25-pin connector
TTL	Shared port with RS-232
Average Linear Force	47 lbs
Drive Motor	0.9° stepping motor
Motor Drive Control	1/4 microstepping
Motor Step per One Revolution of Lead Screw	3200 at 1/4 stepping
Resolution	0.33 µm/step
Step Rate:	
Minimum	6.8 sec/step
Maximum	416.7 µsec/step
Pusher Travel Rate:	
Minimum	2.9068 µm/min
Maximum	47.6 mm/min
Power	30 W, 0.5 A fuse
Voltage Range	95 to 130 VAC, 60 Hz; 220 to 260 VAC, 50 Hz, selectable
Dimensions, H x W x D	28 x 22.2 x 14 cm (11 x 8.75 x 5.5 in)
Weight	4.5 kg (10 lb)

Catalog No.	$	Product
BS4 55-2222		Pump 22 Infusion Only with Standard Syringe Holder
BS4 55-2275		Pump 22 Infusion Only with Anti-Siphon[1] Standard Syringe Holder
BS4 55-5920		Pump 22 Infusion Only with 6/10 Multi-syringe Rack
BS4 55-2314		Pump 22 Infusion Only with 4 x 140 Multi-syringe Rack
BS4 55-2226		Pump 22 Infusion/Withdraw with Standard Syringe Holder
BS4 55-2219		Pump 22 Infusion/Withdraw with 6/10 Multi-syringe Rack
BS4 55-2316		Pump 22 Infusion/Withdraw with 4 x 140 Multi-syringe Rack
BS4 55-4153		Pump 22 Infusion/Withdraw with Microliter Syringe Holder

1. Anti-Siphon syringe holder secures syringe plunger to pusher block

Pump 33 Dual Syringe Pump



- Two independent pumps in a single package
- Operate each pump independently at its own flow rate to either infuse or withdraw
- Synchronize the two pumps for all types of exchange procedures and dilutions of identical amounts
- Deliver or withdraw continuously, 24 hours a day
- 2 year warranty

The Harvard 33 Dual Syringe Pump offers continuous infusion or withdrawal, 24 hours a day, 365 days a year with the accuracy and low flow of a Harvard syringe pump.

The Harvard 33 Dual Syringe Pump is a breakthrough in pumping technology. The 33 has two independent pumping channels linked through hardware and software. When combined with a valve box, it provides the continuous delivery of a peristaltic or piston pump with the accuracy, absence of pulsation and low flow rates of a syringe pump.

The Harvard 33 Dual Syringe Pump opens up whole new pumping possibilities. These are some of the applications of this pump:

- The injection of dyes, perfumes and flavoring in industrial applications
- Applications with liquids or viscous materials in micro-manufacturing
- Continuous injections of reactants into reactor vessels
- Simultaneous samplings from two sites
- Continuous injection for long term toxicology testing

Several modes of operation are available to accommodate a range of setups and experimental protocols. A unique movable limit switch mechanism is used to change direction or stop operation of the pump depending on the mode of operation.

Reciprocal/Parallel Mode - Syringe mechanisms can run in the same or opposite directions (i.e. both infusing/withdrawing at the same time or one infusing and the other withdrawing)

Proportional Mode - Different flow rates and syringe diameters can be set for each syringe mechanism

AutoStop Mode - Pump stops operation when a limit switch is activated.

Continuous Run Mode - When a limit switch is activated each syringe mechanism reverses direction.

The pump has high pressure capability and TTL and RS-232 interface for data acquisition and control. The communication ports enable daisy-chaining of up to 100 pumps.

Specifications

Type	Microprocessor dual drive, single syringe, infusion/withdrawal
Accuracy	±0.35%
Reproducibility	±0.1%
Syringe sizes:	
Minimum	0.5 µl
Maximum	140 ml
Flow Rate:	
Minimum	0.0004 µl/hr
Maximum	106.6 ml/min
Non Volatile Memory	Storage of all settings
RS-232	RJ11-4 conductor
TTL	9-pin connector
Average Linear Force	57 lbs
Drive Motor	2 motors, each 0.9° stepper motors
Motor Drive Control	Microprocessor controlled from 1/2 to 1/4 microstepping
Motor Step per Revolution of Lead Screw	1600 at 1/2 stepping or 3200 at 1/4 stepping
Step Rate:	
Minimum	27.3 sec/step
Maximum	416.7 µsec/step
Pusher Travel Rate:	
Minimum	0.726699 µm/min
Maximum	95.25 mm/min
Power	45 W, 1.0 A fuse
Voltage Range	95 to 130 VAC, 60 Hz; 220 to 260 VAC, 50 Hz, selectable
Dimensions, H x W x D	15.2 x 31.1 x 28.6 cm (6 x 12.5 x 11.25 in)
Weight	6.8 kg (15 lb)

Catalog No.	$	Product
BS4 55-3333		Harvard 33 Dual Syringe Pump

For Accessories, see page A19.

Harvard PHD 22/2000 Advanced Syringe Pumps

- High accuracy and precision
- Low flow rate
- Ultimate flexibility and versatility
- 2 year warranty

Forty years ago Harvard Apparatus perfected the lead screw principle and created the first syringe pump. Since that time, tens of thousands of Harvard pumps have earned a reputation as the most reliable research partners in every major laboratory in the World. The PHD 22/2000 syringe pump series gives you the lowest flow rates ever, the highest accuracy, the smoothest flow, advanced programmability from the keypad and yet, is very easy to use.

Highest Accuracy and Precision

A welded steel chassis, machined Delrin™ components, upgraded guide rods, and advanced electronics give accuracy within 0.35% and reproducibility within 0.05%.

Lowest Flow Rates

A new micro stepping motor and control software give the lowest flow rates ever, down to 0.0001 µl/hour. It is also incredibly quiet so it won't disturb your experimental subjects.

Versatility

There is a PHD 22/2000 syringe pump to meet every need, whether it be simple infusion, infusion and withdrawal, or programming capabilities.

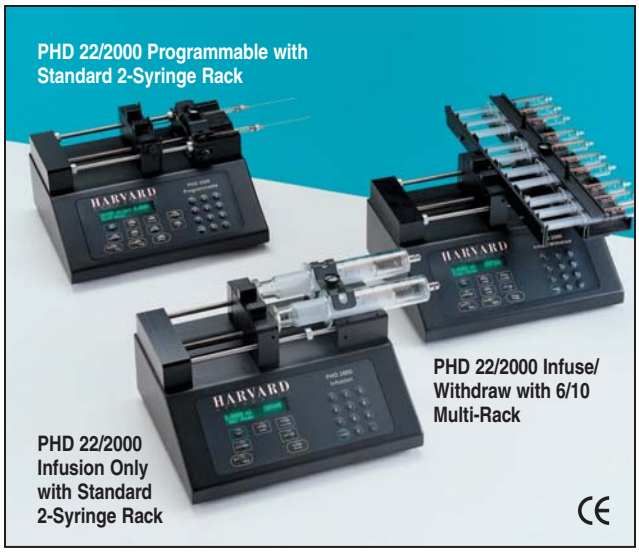
1. **Infuse Only:** This pump is suitable for applications that require high accuracy and low rates but, do not need to withdraw fluid and do not need programmability. Should you need withdrawal or program capabilities later on, the infusion only pump can be upgraded
2. **Infuse/Withdraw:** The Harvard PHD 22/2000 infuse/withdraw has identical performance to the infusion only model (above) but can also withdraw (refill).
3. **Programmable:** The Harvard PHD 22/2000 Programmable pump has the most advanced programming functions and yet is very easy to use. The pump can store up to four programs of 10 sequences each. Programs are stored in non-volatile memory. No other pump can give you this level of control and flexibility. The programmable pumps may also be programmed using Symphony, Harvard's Windows™ pump manager software, see page A17.

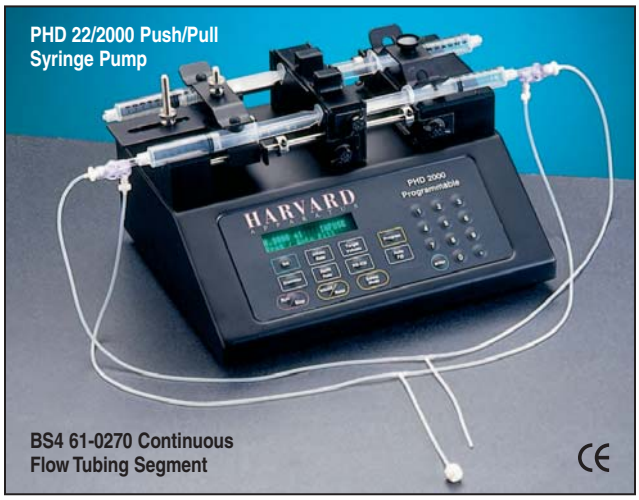
Easy to Use

A bright, easy to read, two-line fluorescent display can be easily read from across the lab. A target volume key makes it easy to dispense a set volume. An ergonomic 'Autolock' release mechanism is easy for even small hands to operate and can never be left unlocked. The numerical keys utilize the familiar 'telephone' layout.

Upgrade

We offer pumps that can be upgraded. If you buy an infuse/withdraw pump and later decide you want programmability you can upgrade it. You pay a lot less than buying a whole new pump.





Program Description

The programming functions of this pump provide powerful capabilities for advanced experiments. While in program mode this pump can perform the following tasks at a predetermined time or when prompted by a signal from an external device:

- Start or stop pumping
- Change pumping direction (infuse-withdraw)
- Change flow rates
- Pump a precise volume and stop
- Pause operation
- Ramp up or down flow rates

In program mode the above tasks can be linked together into powerful programs to simplify your automation projects.

Harvard PHD 22/2000 Advanced Syringe Pumps (Continued)

Introducing the three newest members to join the PHD 22/2000 family:

High Pressure Syringe Pumps

Every version of the PHD 22/2000 Pump is now available with a stronger motor that can provide more force. These pumps are ideal when working with viscous fluid or when driving multiple syringes. The standard force PHD 22/2000 series syringe pump delivers an average nominal force of 50 lbs. while the high power version delivers 66 lbs. If you require even greater force see the PHD 22/2000 Hpsi or the Pump 4400 Hpsi. Visit our website.

Remotely Controlled Syringe Pump

Use the Hpsi remote pump in hazardous environments where the researcher is safer when distanced from the material being pumped. This pump has a 30 foot cable that allows the pumping mechanism to be located remotely from the control box. Every version of the PHD syringe pump is available in a remote model (pictured above).

Push/Pull Syringe Pump

The third new member to the PHD 22/2000 family is the Push/Pull PHD 22/2000. This pump can simultaneously infuse and withdraw the exact amount. Use this when you do not want the volume infused to alter pressure. With the addition of a BS4 61-0270 Tubing Segment or a valve box, it can also provide continuous infusion. It is available in both infuse/withdraw and programmable models. The right side syringe holder is the standard 2-syringe rack found on all PHD 22/2000 syringe pumps. This standard holder will accept all the PHD 22/2000 multi-syringe racks (right side only).

Specifications

Type	Microprocessor driven syringe pump
Accuracy	±0.35%
Reproducibility	±0.05%
Syringes Size:	
Minimum	0.5 µl
Maximum	140 ml
Flow Rate:	
Minimum	0.0001 µl/hr
Maximum	220.82 ml/min
Non Volatile Memory	Stores all settings
RS-232	RJ11-4 conductor
TTL	9 pin D-Sub. Connector
Average Linear Force:	
Standard	50 lbs
High Pressure	66 lbs
Drive Motor	1.8° stepper motor
Motor Drive Control	Microprocessor controlled from 1/2 to 1/32 microstepping
Motor Steps per one revolution of lead screw	From 800 to 12,800
Step Resolution	0.082 µm/step
Step Rate:	
Minimum	27.3 sec/step
Maximum	416.7 µsec/step
Step Resolution	0.082 µm/step
Pusher Travel Rate:	
Minimum	0.18 µm/min
Maximum	190.676 mm/min
Power	65 W, 0.5 A fuse
Voltage Range	95 to 130 VAC, 60 Hz; 220 to 260 VAC, 50 Hz, selectable
Cable Length	9.1 m (30 ft) for remote models only
Dimensions, H x W x D	15.9 x 22.8 x 27.9 cm (6.3 x 9 x 11 in)
Weight	4.5 kg (10 lb)

For Accessories, see page A19.

For Stainless Steel Syringe, see page A70.

For GASTIGHT® Syringes, see pages A73 and A74.

For Plastic Syringes, see pages A76 and A77.

For Luer Tubing Sets and Connectors, see pages A88 to A91.

For ordering information, see page A15.

Precision Syringe Pumps

Infusion Only Models

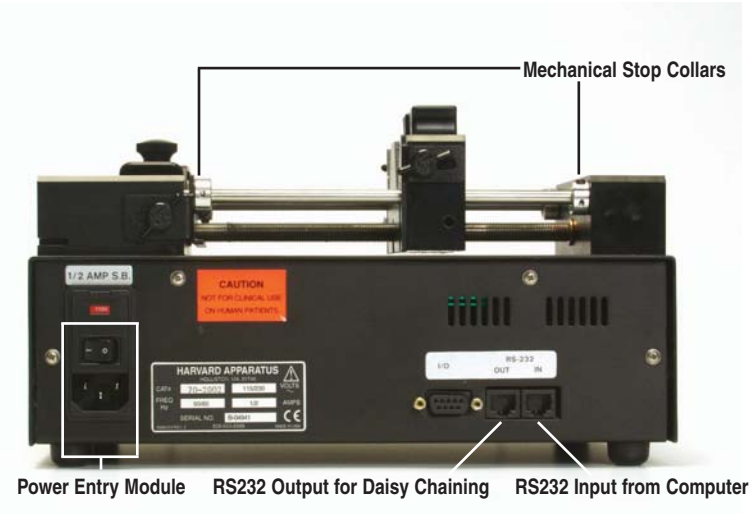
This keypad is on all the infusion only models and offers a single pumping direction. It provides access to all the basic functions of the pump. It features a "Target Volume" button that permits the dispensing of a predefined volume. This is a nice feature when you want to dispense a specific volume. This mode is very safe because it protects syringes and will stop the pump automatically even if the user is not present.

Infuse/Withdraw Models

With the addition of the "Infuse/Refill" and "Refill Rate" buttons on this keypad, the infuse/withdraw models permits the pusher block to move both forward and reverse. This allows the syringes to infuse and withdraw. The reversal is manually controlled via the keypad or RS232. For continuous delivery with automatic reversal see the programmable models below.

Programmable Models

This keypad has two additional buttons. The "Program" and "Auto Fill" buttons. With this pump you can actually program a sequence of pumping steps. You can start or stop the pump, change the pumping direction, change the flow rate, pump a precise volume and stop, pause the pump and even ramp up or ramp down the flow rate. All of these tasks can be linked together in a sequence providing a powerful tool to simplify and automate complicated pumping processes. The Auto Fill key is useful when user would like to deliver a large volume of fluid. The user sets a target volume and then programs the refill volume for the syringe. The pump will automatically refill the syringe as many times as required to reach the target volume. Then the pump will automatically stop. This process does require the use of a valve.



Rear Panel of the Pump

On the back side of all PHD 22/2000 Syringe Pump are two RS232 ports. One is for input from a computer and the second is for output when daisy chaining more than one pump together. The I/O port is a 9-pin D sub connector and is used for TTL control. Also on the back is the universal power entry module which encompasses the ON/OFF switch, fuse and universal power supply. This power supply will accept power input from 110 to 240 VAC, 50/60 Hz. The mechanical stop collors cause the pump to stop automatically, thus protecting expensive syringes.

Harvard PHD22/2000 Advanced Syringe Pumps (Continued)

PHD 22/2000 Syringe Pumps	Infusion Only				Infuse/Withdraw				Programmable			
Syringe Pump Versions	Standard Force	$	High Force	$	Standard Force	$	High Force	$	Standard Force	$	High Force	$
Standard Syringe Pumps												
Standard 2-Syringe	BS4 70-2000		BS4 71-2000		BS4 70-2001		BS4 71-2001		BS4 70-2002		BS4 71-2002	
6/10 Multi-Rack	BS4 70-2003		BS4 71-2003		BS4 70-2006		BS4 71-2006		BS4 70-2009		BS4 71-2009	
4 x 140 Multi-Rack	BS4 70-2004		BS4 71-2004		BS4 70-2007		BS4 71-2007		BS4 70-2010		BS4 71-2010	
Microliter Rack	BS4 70-2005		BS4 71-2005		BS4 70-2008		BS4 71-2008		BS4 70-2011		BS4 71-2011	
Remote Syringe Pumps												
Standard 2 Syringe	BS4 70-2100		BS4 71-2100		BS4 70-2101		BS4 71-2101		BS4 70-2102		BS4 71-2102	
6/10 Multi-Rack	BS4 70-2103		BS4 71-2103		BS4 70-2106		BS4 71-2106		BS4 70-2109		BS4 71-2109	
4 x 140 Multi-Rack	BS4 70-2104		BS4 71-2104		BS4 70-2107		BS4 71-2107		BS4 70-2110		BS4 71-2110	
Microliter Rack	BS4 70-2105		BS4 71-2105		BS4 70-2108		BS4 71-2108		BS4 70-2111		BS4 71-2111	
Push/Pull Syringe Pumps												
Standard	–		–		BS4 70-2020		BS4 71-2020		BS4 70-2019		BS4 71-2019	
Remote	–		–		BS4 70-2120		BS4 71-2120		BS4 70-2119		BS4 71-2119	

Harvard PHD 22/2000 Pump Series		
Catalog No.	$	Syringe Rack Kits and Upgrades
Syringe Rack Kits[1]		
BS4 70-2012		PHD 22/2000 6/10 Multi-Rack Upgrade Kit
BS4 70-2013		PHD 22/2000 4 x 140 Multi-Rack Upgrade Kit
BS4 70-2014		PHD 22/2000 Microliter Rack Upgrade Kit
BS4 70-2015		PHD 22/2000 Anti-Siphon Kit (Infusion Only Pump)
Upgrades[2]		
BS4 70-2016		PHD 22/2000 Infusion to Infuse/Withdraw
BS4 70-2017		PHD 22/2000 Infuse/Withdraw to Programmable
BS4 70-2018		PHD 22/2000 Infusion Only to Programmable

1. *These multiple syringe racks will fit any PHD 22/2000 series syringe pump listed above and are easily interchangeable.*
2. *Upgrades are available for Infusion Only and Infuse/Withdraw models of PHD 22/2000 series pumps. All upgrades must be factory installed.*

Continuous Flow Tubing Segment

This continuous flow tubing segment is used with the PHD 22/2000 Push/Pull Syringe Pump. It makes continuous flow possible.

Specifications	
Tubing	0.062 in. ID Tygon® tubing
Tubing Length	3 x 112 in. sections
Max. Pressure	15 p.s.i.
Valve Materials	Polycarbonate, silicone

Catalog No.	$	Product
BS4 61-0270		Continuous Flow Tubing Segment

Remote Extension Cables

Replacement cables for PHD 22/2000 remote syringe pumps including the PHD 22/2000 Hpsi, see page A16. The cables can also be used to increase or decrease the distance between the pump mechanism and controller.

Catalog No.	$	Product
BS4 72-0199		Remote Extension Cable, 1.5 m (5 ft)
BS4 72-1405		Remote Extension Cable, 9.1 m (30 ft)

For Symphony Software, see page A17.

For Accessories, see page A19.

For GASTIGHT® Syringes, see pages A73 and A74.

For Plastic Syringes, see pages A76 and A77.

For Stainless Steel Syringe, see page A70.

For Tubing, see pages A78 to A87.

For Luer Connectors and Kits, see pages A88 to A91.

We also offer Symphony, a Windows™ based pump managing program that allows you to program the pump easily from your computer, see page A17 for complete details.

NEW PHD 22/2000 Hpsi (High Volume & Pressure)

BS4 70-2023 PHD 22/2000 Hpsi with four 200 ml Stainless Steel Syringes (syringes not included)

- High capacity — up to 800 ml with four 200 ml syringes
- Ultra high pressure — provides over 400 lbs of pumping force
- ±0.5% precision
- ±0.1% reproducibility
- Programmable — advanced capabilities with programming from the keypad
- Built to last — rugged construction for a lifetime of service
- Accepts only Harvard's stainless steel syringes
- 2 year warranty

High Capacity

This NEW PHD 22/2000 Hpsi Syringe Pump provides the highest capacity output of all of Harvard Apparatus' microprocessor syringe pumps. This pump can hold up to four syringes from 20 to 200 ml. By combining the output from four 200 ml syringes, this pump is able to infuse up to 800 ml of fluid without refilling.

Ultra High Pressure

This NEW PHD 22/2000 Hpsi Syringe Pump over 400 pounds of force against the syringe plungers, higher than any other pump we manufacture. For applications with viscous fluids or requiring high pressure, this is the pump to handle the job.

Versatility

This Programmable PHD 22/2000 Hpsi syringe pump provides advanced capabilities directly from the keypad. No external computer is required. The pump can store up to four programs of 10 sequences each. Programs are stored in non-volatile memory. No other pump can provide this level of control and flexibility with the accuracy of the PHD 22/2000 syringe pump series. Like all of Harvard Apparatus' other pumps, this new high capacity pump is easy to use.

Built-to-Last

This pump uses high quality, industrial grade components that will deliver years of smooth operation.

To Accommodate Almost Every Workbench

This pump is provided with a standard 5 foot cable that connects the control box to the pumping mechanism box. If additional distance is required between the controller and pump, a 30 foot remote extension cable is offered as an accessory.

Stainless Steel Syringes

Only Harvard Apparatus' stainless steel syringes can be used with this pump. They can withstand high pressure applications and provide years of service, see page A70.

Flow Rates for PHD 22/2000 Hpsi (High Volume and Pressure)
The Rates listed are for Single Syringe

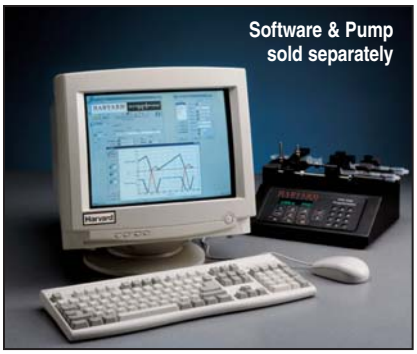
Syringe Size	Minimum	Maximum
20 ml	1.5 µl/hr	20 ml/min
50 ml	3.4 µl/hr	46 ml/min
100 ml	5.0 µl/hr	68 ml/min
200 ml	8.2 µl/hr	112 ml/min

Specifications

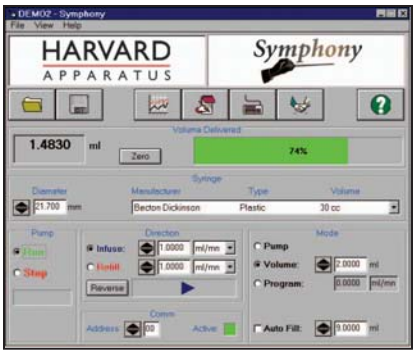
Type	Microprocessor driven syringe pump
Accuracy	±0.5%
Reproducibility	±0.05%
Syringes (Min/Max)	Holds 20 to 200 ml stainless steel syringes
Flow Rate:	
Minimum	1.5 µl/hr
Maximum	112 ml/min
Non Volatile Memory	Stores all settings
RS-232	RJ11-4 conductor
TTL	9 pin D-Sub. Connector
Average Linear Force	433 lbs
Drive Motor	1.8° stepper motor, geared 1:10
Motor Drive Control	Microprocessor controlled from 1/2 to 1/32 microstepping
Motor Steps per one Revolution of Lead Screw	From 8,000 to 128,000
Step Rate:	
Minimum	27.3 sec/step
Maximum	416.7 µsec/step
Pusher Travel Rate:	
Minimum	0.09 µm/min
Maximum	71.210 mm/min
Power	65 W, 0.5 A fuse
Voltage Range	95 to 130 VAC, 60 Hz; 220 to 260 VAC, 50 Hz, selectable
Cable Length	152 cm (60 in) approx.
Dimensions, H x W x D:	
Control Box	9.5 x 27.9 x 22.9 cm (3.75 x 11 x 9 in)
Syringe Holder	22.9 x 43.2 x 30.5 cm (9 x 17 x 12 in)

Catalog No.	$	Product
BS4 70-2023		PHD 22/2000 Hpsi
BS4 72-0199		Remote Extension Cable, 1.5 m (5 ft)
BS4 72-1405		Remote Extension Cable, 9.1 m (30 ft)
BS4 70-2022		PHD 22/2000 RS-232 Adapter, 9-pin to standard phone jack
BS4 70-2263		SS Syringe, 200 ml, with 1/16 inch SWAGELOK®
BS4 70-2264		SS Syringe, 200 ml, with 1/8 inch SWAGELOK®
BS4 70-2265		SS Syringe, 200 ml, with 1/4 inch SWAGELOK®
BS4 70-2266		SS Syringe, 200 ml, with Luer Lock

Symphony – The Windows™ Pump Manager



- Windows™ based software
- Remotely control and program your pump from your PC
- Graphically displays what your pump is doing
- Control multiple pumps
- Printable log of pumping events



Symphony – The Windows™ Pump Manager

Symphony is designed to work with Harvard Apparatus syringe pumps. Both the PHD 22/2000 programmable series of syringe pumps and the PHD 4400 Hpsi programmable syringe pump will work with Symphony.

Easy to Use

Symphony is an easy to use, Windows™ based application. You change pump parameters using common Windows™ controls like pull-down menus, direct numeric entry, on-off buttons and 'spin' controls.

Interactive Pump Control Window

The interactive pump control window allows you to set, on-the-fly, all pump parameters including:

- Syringe type and diameter
- Flow rates
- Pumping modes (pump, volume, program and auto-fill)

Values can be directly entered into fields or selected via scrolling.

Single or Multiple Pump Control

Multiple pumps can be controlled by Symphony. Create the protocol for the first pump and then connect other pumps directly to that pump. This creates a daisy chain which allows the software to drive all pumps in the chain. Note that the protocol is identical for each pump in the chain.

Information at a Glance

The main window displays all of the pumping parameters for the individual pump in an easy to read format. Information such as volume delivered, direction of flow, pumping mode, syringe used, and flow rates, are clearly displayed. Even the communications port identity and status is displayed. The researcher needs only to glance at this window to know what the pump is doing.

Reliable Communication with No Guess Work

On the interactive pump control window, there is a pump status box. A light will blink green if communication is normal and red if you have a communication error. At a glance you will know if the software is communicating with your pump. There is no guess work.

From the interactive pump control window you gain access to all other Symphony windows through pull down menus or icon buttons.

Pump Program Window

The program window allows you to create, review, edit, save, recall and download programs. Using standard Windows™ software icons and menus, programming your pump is as simple as clicking a mouse. Once created, a program can be downloaded to any pump in the communications chain and it can be saved and recalled for later use. Note that programming only works with a PHD 22/2000 Programmable Pump or PHD 4400 Hpsi. It will not work with a PHD 22/2000 Infusion Only or PHD 22/2000 Infusion/Withdraw syringe pumps.

Use one of the five sample programs included with Symphony or create your own.

Pump Graph Window

This window displays an easy to read graph that resembles a continuously running strip chart recorder. This allows you to monitor infuse and refill rates and volume dispensed. Infusion values are displayed in blue and refill values in red. The vertical axis scale (range) and horizontal axis, chart speed (period), are selectable.

Log Sheet

Symphony creates a log sheet that tracks the activity of your pumps. Later, the information can be reviewed using a Windows™ text editor or word processor program. The log update period is user selectable. Files are stored in *.vpl file format and can be printed and saved as needed.

System Requirements (Minimum)

Hardware	Intel compatible 486/33 computer with 8 MB RAM, hard disk drive with 2 MB available space, 3.5 inch floppy disk drive, mouse
Software	Windows™ 3.1, 95, 98, 2000
Monitor	VGA or higher display and driver capable of 800 x 600 resolution with one unused serial communication port

Catalog No.	$	Product
BS4 70-3000		Symphony - The Windows™ Pump Manager

NEW PHD 4400 Hpsi High Force/High Pressure Programmable Syringe Pump

- Delivers >200 lbs (91 kg) linear pumping force across a wide flow rate range
- Accurate and smooth flow
- Ideally suited for stainless steel syringes
- Easy-to-use interface
- Control from your PC via serial interface
- 2 year warranty

The PHD 4400 Hpsi Programmable Syringe Pump is a single syringe infuse-withdraw pump equipped with all the functions of the PHD 22/2000 Programmable Model, but with a high-power stepper motor to provide up to 200 lbs. of linear force.

Pressure and Speed

The PHD 4400 Hpsi can deliver up to 220.82 ml/min with a single 140 ml syringe. Maximum pressure is dependent on syringe size. For stainless steel syringes, see page A70.

Flexibility and Easy Programmability

- Two standard infusion modes (continuous or volume dispense)
- Internal programmable pump control in all models
- In Program Mode, complex infuse and withdraw applications can be easily created, stored in the pumps nonvolatile memory and recalled for later use.
- Autofill Mode provides continuous delivery when the pump is used in conjunction with either a standard or high pressure valve box and a fluid reservoir.

Ease of Use

Setting the pump is quick and easy. Input the diameter of the syringe or use the internal Syringe Lookup Table to automatically input the syringe diameter based on the syringe manufacturer and size. Select a mode (continuous delivery or volume dispense) and a rate and you are ready to go.

Features

Universal Input Power Supply: No need to change AC line switches, fuses, or wires.

Nonvolatile Memory: Stores all operational data and program sequences.

Stall Detection: An optical detector verifies motor movement. Stalls due to jamming or excessive back pressure are reported.

Visual/Audible Alarms

Power-Up Options: Powers-up in Standby or Running Mode after power interruption.

RS-232 Connections: Allows daisy-chaining of multiple pumps for remote control. Also allows for scale and printer connections.

TTL Connections: Allows for synchronizing pump with external devices, controlling an external valve, changing direction of travel, etc.

Modes of Operation

Pump Runs continuously in the infuse or refill directions until stopped.

Volume Runs until specified volume has been pumped or refilled.

Program Pump operates according to specified sequence of instructions. (Note: All modes interact with Autofill feature.)

Specifications

Accuracy	±0.35%
Reproducibility	±0.05%
Syringes	0.5 µl min/140 ml max single syringe
Flow Rate:	
Minimum	0.0001 µl/hr (with 0.5 µl syringe)
Maximum	220.82 ml/min (with 140 ml syringe)
Calibration	Automatic
Display	2-line, 40 character fluorescent
Memory	Nonvolatile (stores all settings)
Interface	RS-232 multiplexed dual bidirectional ports
Connectors:	
RS-232	RJ-11 4-conductor telephone plug
TTL	9-pin D-SUB connector
Linear Force	>200 lbs (91 kg)*
Fluid Pressure*	>1,800 psi with an 8 ml stainless steel syringe, for example
Drive:	
Motor	1.8° stepper
Control	Microprocessor (from 1/2 to 1/32 microstepping)
Step/Rev.	From 800 to 12,800
Step Rate:	
Minimum	27.3 sec/step
Maximum	416.7 µsec/step
Pusher Travel Rate:	
Minimum	0.18 µm/min
Maximum	190.676 mm/min
Resolution	0.082 µm/step
Power	100-240 VAC, 50/60 Hz, 75 W, 0.75 A fuse
Dimensions, H x W x D	17 x 23 x 29 cm (6.7 x 9.0 x 11.4 in)
Weight	6.4 kg (14 lbs)
Remote Cable	9.1 m (30 ft) Length

* For work range, refer to User's Manual for details.

Catalog No.	$	Model
BS4 70-2200		PHD 4400 Hpsi Programmable Syringe Pump, Standard
BS4 70-2201		PHD 4400 Hpsi Programmable Syringe Pump, Remote

Accessories for Syringe Pumps


BS4 55-3337 Continuous Delivery Valve Box - High Pressure

Continuous Delivery Valve Box

The Continuous Delivery Valve Box for Normal Pressure is supplied with 3.2 mm ID x 6.4 mm OD (1⁄8 x 1⁄4 in) silastic tubing and a connector cable to the syringe pump. For use with the pump 33 (BS4 55-3333) only. Maximum pressure 30 p.s.i.


BS4 55-3336 Normal Pressure

The Continuous Delivery Valve Box High Pressure has the valve assembly with lines for two syringe connections. Made of 304 stainless steel throughout it with 6.4 mm (1⁄4 in) ID stainless steel tubing with SWAGELOK® Fittings and the connector cable to the syringe pump. For use with the pump 33 (BS4 55-3333) only. Maximum pressure 200 p.s.i. Wetted parts are stainless steel and viton.

Catalog No.	$	Product
BS4 55-3336		Syringe Pump 33 Continuous Delivery Valve Box, Normal Pressure
BS4 55-3337		Syringe Pump 33 Continuous Delivery Valve Box, High Pressure

Daisy-Chain Connector and Cable

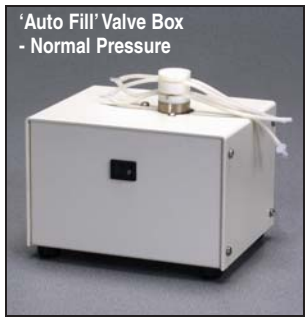
For use with PHD 22/2000, see pages A12 to A15; Pump 4400 Hpsi, see page A18; Pump 33, see page A11; Pump 66/77, see page A43; PHD 22/2000 Hpsi, see page A16; and Pump 22, see page A10 (requires BS4 72-2479 Interface Box). Up to 100 syringe pumps (PHD 22/2000, Pump 22, Pump 33, and Pump 4400 Hpsi) can be joined together by Daisy-Chain cables and operated from a single computer. A single BS4 55-4145 Daisy-Chain Connector is required to connect the computer to the first pump in the chain. One Daisy-Chain cable BS4 55-7760 or BS4 72-2478 is required for each additional pump in the chain.

Catalog No.	$	Product
BS4 70-2022		Daisy-Chain Connector, 9 pin D-Sub
BS4 55-4145		Daisy-Chain Connector, 25 pin D-Sub
BS4 55-7760		Daisy-Chain Cable, Interconnects 2 Pumps, 0.6 m (2 ft)
BS4 72-2478		Daisy-Chain Cable, Interconnects 2 Pumps, 1.8 m (6 ft)

Pump 22 Reversing Switch

Allows pump to operate in either Infusion or Withdraw modes. Requires Withdrawal Bracket (call for details) which is not included.

Catalog No.	$	Product
BS4 55-2217		Pump 22 Reversing Switch


'Auto Fill' Valve Box - Normal Pressure

- Available for normal or high pressure

'Auto Fill' Valve Box

The 'Auto Fill' valve box for normal pressure has a one sided pinch assembly. For use with the PHD 22/2000 (Infuse/ Withdraw and Programmable models only, see page A12, and the pump 4400 Hpsi, see page A18. Supplied with 3.2 mm ID x 6.4 mm OD (1⁄8 x 1⁄4 in) silastic tubing and 115/230 VAC, 50/60 Hz electrical connector with syringe pump connector cable. Maximum pressure 50 p.s.i.

The 'Auto Fill' valve box for high pressure is for use with PHD 22/2000 Infuse/Withdraw and Programmable models only, see page A12, and the pump 4400 Hpsi, see page A18. 304 stainless steel throughout. Supplied with 6.4 mm (1⁄4 in) ID stainless steel tubing with SWAGELOK® fittings to mate with Harvard stainless steel syringes, and 115/230 VAC, 50/60 Hz electrical connector with syringe pump connector cables. Maximum pressure 200 p.s.i. Wetted parts are stainless steel and viton.

Catalog No.	$	Product
BS4 55-1146		'Auto Fill' Valve Box - Normal Pressure
BS4 55-1145		'Auto Fill' Valve Box - High Pressure

Audible Alarm

Activated when the syringe reaches the end of its travel or back pressure exceeds the capacity of the Pump. Plugs into a 9-pin or 25-pin TTL connector. Measures 6.4 x 6.4 x 1.3 cm (2-1/2 x 2-1/2 x 1/2 in). For use with Pump 33, see page A11; Pump 4400 Hpsi, see page A18; and Pump 22, see page A10.

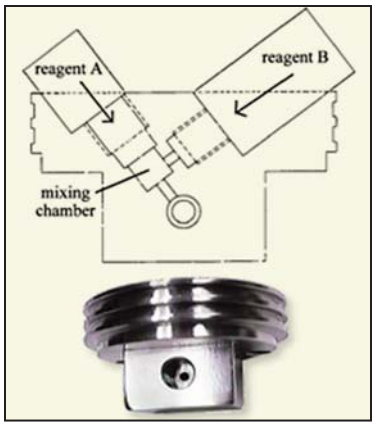
Catalog No.	$	Product
BS4 55-2317		Audible Alarm

Foot Switch

The foot switch is for use with all Versions of the PHD 22/2000, see pages A12 to A15; all Versions of the Pump 4400 Hpsi, see page A18; Pump 33, see page A11; Pump 66/77, see page A43; and Pump 22, see page A10 (requires BS4 72-2479 – Interface Box). This start/stop foot switch which plugs into the 9-pin TTL connector provides 'hands-off' control.

Catalog No.	$	Product
BS4 55-4144		Foot Switch

Stopped-Flow Cell Assemblies



- Ideal for stopped-flow kinetics applications
- For use with any Pump Type
- Low volume design
- Low 1 to 5 msec dead time
- Ceramic valves
- Safety interlock system for 100% assurance against misfiring

These Stopped-Flow mixers for use with spectrophotometers are for the rapid preparation of reactive solutions. The assemblies are designed with mounts for absorbance, fluorescence and circular dichroism. These mounts also allow the mixers to be used with most spectrophotometers.

These Stopped-Flow Cell Assemblies include many key features, including a 1 to 2 msec dead time for absorbance and fluorescence and 3 to 5 msec for circular dichroism. The low volume design supports volumes of 40 to 70 µl/syringe/shot, compared to the average reagent volume of 70 to 120 µl. The drive syringes are SGE® glass, and low-temperature syringes are also available. The valves are made of fired sapphire ceramic which are inert, impervious to temperature extremes, and very hard. All Mixers are Ball-Berger, with pneumatic drive mechanism and horizontal drive syringe orientation. All mixers support reagent ratios of 1:1 to 1:10 as determined by syringe sizes.

The four Stopped-Flow Mixers are identical except for their sample cell assemblies. Please choose your mixer based on intended application use.

Classic Ambient Temperature Cell Assembly

The Classic Stopped-Flow Cell Assembly supports both absorbance and fluorescence measurements at moderate temperatures; because Teflon™ is used in the cell, temperatures below approximately 10°C are impractical. For fluorescence measurements, a mirror attachment is available to maximize emission collection. The mirror attachment slides over the cell assembly such that the mirror is positioned directly behind the rear window; emissions that would be lost through the rear window are thereby reflected towards the detector. The 20 mm quartz flow tube is mounted between a pair of Teflon™ end caps. A quartz window is installed in the end of each cap. Mixed reagents enter and exit the flow tube through the small holes in the end caps.

Low-Temperature Absorbance Cell Assembly

The Low-Temperature Absorbance Cell Assembly is one of two stopped-flows optimized for low-temperature experiments. This low-temperature absorbance stopped-flow has a stainless steel flow cell assembly with a 10 mm optical path length. The flow path is drilled directly through a solid block of stainless steel.

Low-Temperature Fluorescence Cell Assembly

The Fluorescence-optimized Stopped-Flow Cell Assembly supports absorbance measurements with a short path length. Like the Classic Absorbance/Fluorescence Cell Assembly, the Fluorescence-optimized Cell Assembly has an upper temperature limit of 80°C. This stopped-flow cell assembly uses a 4 mm flow cell made of Suprasil (UV-optimized fused silica).

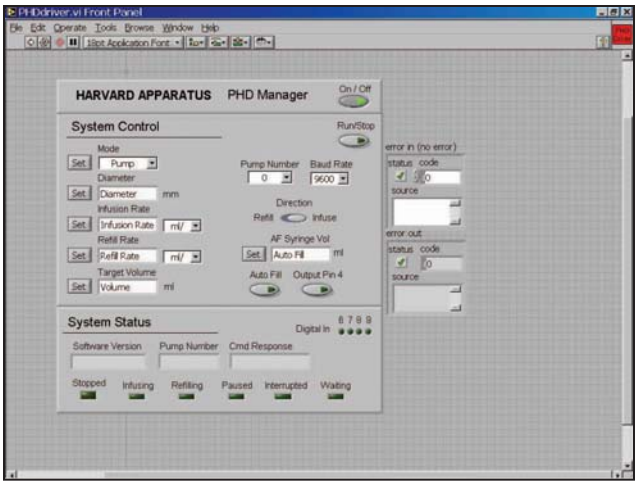
Circular Dichroism with Stopped-Flow

Combining Circular Dichroism (CD) with stopped-flow speed mixing means detecting milliabsorbance signals on a millisecond time scale. Rendering this difficult measurement more practical is the CD Stopped-Flow Spectrophotometer. Fixed wavelength detection, recommended for all the more difficult measurements including UV readings, is done by sampling 1,000 times per second. With this millisecond detection rate, one can obtain excellent kinetic traces and calculate rate constants. Rapid-scanning detection, suitable for all of the easier measurements, including visible readings, can be done by sampling at rates to 62 CD scans per second. With this millisecond spectral detection rate, one can obtain kinetics at hundreds of wavelengths, supporting not only rate constant calculation but also spectral reconstruction.

Catalog No.	$	Product
BS4 72-6800		Ball-Berger Mixer Only

Stopped-Flow Cell Assemblies Specifications	Classic Ambient-Temp	Low-Temp Absorbance	Low-Temp Fluorescence	Low-Temp CD
Catalog No. $	BS4 72-6796	BS4 72-6797	BS4 72-6798	BS4 72-6799
Primary Applications	Absorbance and fluorescence ambient temperature	Absorbance low temperature	Fluorescence low temperature	CD low temperature
Other Supported Applications	—	—	Absorbance low temperature	Absorbance low temperature
Temperature Range	10 to 80°C	-30 to 100°C	-30 to 100°C	-30 to 100°C
Optical Pathlength	20 mm for absorbance 2 mm for fluorescence	10 mm	4 mm for fluorescence 4 mm for absorbance	2 mm for CD 2 mm for absorbance
Optical Aperture size	2 mm for absorbance 10 mm for fluorescence	2 mm	2.4 mm x 3.2 mm rectangular	6 mm
Valve Material	ceramic	ceramic	ceramic	ceramic
Flow Tube Material	Suprasil (UV-enhanced fused silica)	Stainless Steel	Suprasil (UV-enhanced fused silica)	Suprasil (UV-enhanced fused silica)

NEW LabView Driver - Take Control Of Your Syringe Pump



Provides

- Virtual control from a PC of one or more syringe pumps
- Access to all basic features of PHD 22/2000 family of syringe pumps
- Syringe pump control for many LabVIEW™ system applications

LabVIEW™ Driver for Harvard Apparatus PHD 22/2000 syringe pump family. Built using the popular LabVIEW‰ programming application for National Instruments.

LabVIEW™, the most widely used software for test, measurement, and control, delivers faster time to measurement with LabVIEW 7. It's easy to develop intuitive LabVIEW block diagrams for your I/O, analysis, and presentation needs. From simple data acquisition to advanced embedded software development, LabVIEW delivers productivity you can measure.

LabVIEW delivers a powerful graphical development environment for signal acquisition, measurement analysis, and data presentation, giving you the flexibility of a programming language without the complexity of traditional development tools.

Engineers and scientists in virtually every industry find that LabVIEW delivers real benefits for a wide variety of applications. Use LabVIEW to reduce time to develop your lab applications and boost your productivity. This software can be included free of charge with any pump purchase, or simply call our customer service department to request you free copy using the catalog number below. Also available as a free download on-line. Visit our website at www.harvardapparatus.com and go to our technical library.

The RS232 accessible through LabView allows for the following:

- Set Auto-Fill Mode
- Set-Up Target Volumes
- Infuse Rate
- Refill Rate
- Diameter of Syringe
- On/Off Button
- Run/Stop
- Baud Rate
- Pump ID Number
- Direction of Flow
- Output for TTL
- Mode Selection
- System Status
- Software Version
- Command Response
- TTL Monitoring Errors

Catalog No.	$	Product
BS4 70-2050		LabVIEW Driver for Harvard Apparatus PHD 22/2000 Syringe Pumps

For PHD 22/2000 Syringe Pumps, see page A12 to A15.

Sensaphone® Remote Monitoring Systems

BS4 72-7573
Senesaphone® 1104

BS4 72-7575 Water Detection Sensor

BS4 72-7574
Senesaphone® 2000

- Monitor your experiments while away from the lab
- Ideal for use with our Syringe Pumps and Fluid Delivery Systems
- Alarms communicated via phone, page, fax and/or email
- Choose from two easily programmable and versatile systems

Harvard Apparatus is pleased to announce a new line of remote monitoring systems. Now you can remotely monitor critical components, such as syringe pumps and fluid delivery systems .The remote monitoring system will report to you critical data wherever you are and whenever you need it. This system gives you the ability to identify critical variations in conditions when no one is on hand to observe them directly. Once a fault has been detected the monitoring system can phone, page, fax and/or email alarms to your attention. The systems also offer customizable voice messages, data radio and cellular communication, data and event logging.

The Sensaphone® 1104 system can monitor temperature, humidity levels, intrusion, water seepage, power or HVAC system failure. The 1104 provides four alarm inputs and four phone numbers. This dependable monitoring system integrates a keypad for easy programmability and has a built-in microphone. When monitoring our syringe pumps, an adapter component is needed. This unit includes a nonvolatile memory and 24- hour battery backup with user installed batteries.

We also offer the Sensaphone® 2000 system that features the most advanced communication features you could ask for. This system combines a sophisticated monitor with user–recorded alarm messages and flexible dial out capabilities to fax machines, pagers, email and computers. This system even generates web pages. This unit comes with eight universally configurable inputs, plus built-in power monitoring, battery level monitoring and nonvolatile memory with an optional battery backup designed for Ni-Cad batteries. The Sensaphone® 2000 can be programmed to communicate with up to 32 destinations to deliver alarm messages or status reports. With its massive internal data logging features it can store up to 32,000 time stamped records of selected inputs, power and/or battery voltage. The Sensaphone® 2000 comes with all the software you will need to communicate, report, and poll data and create web pages.

BS4 72-7576 Temperature Detection Sensor Probe

Also choose from several optional accessories. The Water Detection Sensor can be used with both Sensaphone® models to detect the presence of water on a horizontal surface. This unit is powered by internal lithium batteries, and multiple sensors can be wired in series to a single input. The Weatherproof Temperature Detection Sensor Probe can also be used with both Sensaphone® models to monitor actual temperature from 4.4 to 79.4º C (40 to 175º F) and is accurate to ±0.56º C (±1º F). The probe measures (L x Dia.) 5.08 x 0.64 cm (2 x 0.25 in), and is enclosed in a stainless steel housing with a moisture-resistant seal. It includes a mounting clip and 3.66 m (12 ft) of wire.

To use the Sensaphone® 1104 System with a Harvard Apparatus Pump, please order the Connection Cable BS4 72-7577. The Sensaphone® 2000 System does not require a connection cable.

Specifications

	Sensaphone® 1104	Sensaphone® 2000
Alarm Inputs	4 Dry Contact or Temperature	8 Universal
Sound Monitoring	Yes	No
Power Monitoring	Yes	Yes
Temperature Sensing Range	–20 to 150° F	–58° to 176° F
Voice Alarm messages	Yes	Yes
Programmable Voice	No	Yes
Built-In Modem	No	Yes
Fax Reporting	No	Yes
E-mail Reporting	No	Yes
Alphanumeric Pager	No	Yes
Numeric Pager	Yes	Yes
Dialout Phone Numbers	4	32
Programming:		
Local Keypad	Yes	No
LCD	No	N/A
PC Direct Connect	No	Yes
Remote Touch-Tone	No	No
Remote Data	No	Yes
Data Logging	No	Yes
Battery Backup Time	24 hrs	10 to 15 hrs
Enclosure	Plastic	Aluminum
Dimensions, H x W x D	5.1 x 19.1 x 21.6 cm (2.0 x 7.5 x 8.5 in)	18.3 x 30.7 x 4.1 cm (7.2 x 12.1 x 1.6 in)
Power	120 VAC 60 Hz, 15 W	External transformer 120 VAC 60 Hz, 10 W
Batteries (not included)	(6) 1.5 V "D" cell alkaline	(6) C-cell Rechargeable Ni-Cad
Operating Range	0 to 48.9° C (32 to 120º F)	0 to 50° C (32 to 122° F)

Catalog No.	$	Product
BS4 72-7573		Senesaphone® 1104
BS4 72-7574		Sensaphone® 2000
BS4 72-7575		Water Detection Sensor
BS4 72-7576		Temperature Detection Sensor Probe
BS4 72-7577		Connection Cable for Sensaphone® 1104 to Pump

Harvard 1 Single-Channel Syringe Pump

The Harvard 1 offers the most advanced features in a single-channel syringe pump available today, including an easy-to-read color screen; a fast, sensitive occlusion detection system, bar code capabilities and an extensive drug library. This unique single-channel syringe pump gives you all the benefits of the Harvard 2 in an economical single-channel format.

Simple Setup and Adjustment

Intuitive control knobs replace keypad operation and greatly enhance ease of use. Infusion rate changes can be made while the pump is running. There is no need to stop the pump. Further, all program changes can be made while the pump is running. However, if you do need to stop an infusion and shut off the pump, all infusion settings are saved to minimize setup time.

Easy to Handle and Transport

The system is compact and lightweight so it is easy to carry. A powerful Li-Ion battery ensures long life.

Large, Full-Color Screen

The Harvard 1 is the only syringe pump to offer a color LCD screen with color-coded information visible from up to 6 feet. This unique screen also offers a wide view so that pump information can be viewed at a glance from almost any angle.

Easy Syringe Loading

Load any syringe from 1 ml to 60 ml without hassle or worry with the Harvard 1's innovative loading system. It is quick and easy and it minimizes loading errors. If the syringe is not properly captured, an alarm will sound within 15 seconds. You can be confident that your pump is ready to begin the infusion.

Intelligent Occlusion Sensing

The Harvard 1 offers a unique sensitive occlusion sensing mode. The line pressure is measured at the start of the infusion and the occlusion alarm pressure is set just above the pressure measured. The result is faster times to occlusion alarm and a reduced number of false alarms. A color-coded pressure status bar provides continuous indication of pressure build-up prior to the alarm.

Advanced Near Empty Syringe Warning

For an infusion at a continuous rate, the Harvard 1 displays a warning message 15 minutes before a syringe needs to be replaced. The remaining infusion time will be displayed and will count down in one-minute increments. With such accurate advance notice, you will have adequate time to reload your syringe or prepare for the next procedure.

Flexible Drug Library Tailors the Harvard 1 to Your Research

The Harvard 1 is capable of storing up to 300 drugs, each with infusion defaults and safety rate limit settings. Your custom DRUG LIBRARY is easily loaded into the pump utilizing a Windows-based PC program through the pump's serial communication port.

Bar Code Capabilities

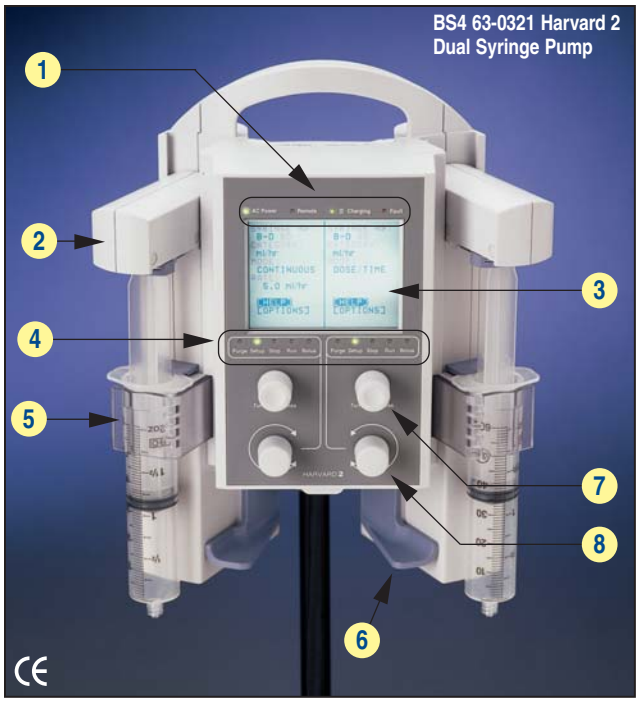
The Harvard 1's new bar-code reading feature (pending 510K clearance) enables lightning-fast drug identification and setting of infusion rates with laser-reading of the drug's bar code (located on the syringe). This new, unique benefit of the Harvard 1 represents a major milestone in the reduction of medication errors.

Specifications

Flow Rates:	
Large Animals	0.01 to 1500 ml/hr
Small Animals	0.01 to 300 ml/hr
Bolus Large Animal	Up to 1500 ml/hr
Bolus Small Animal	Up to 300 ml/hr
Accuracy	±1% (exclusive of syringe variability)
Infusion Delivery Method:	
Units	ml/hr or any of 21 other units
Modes	Continuous, Continuous With Bolus, Dose/Time
Occlusion Sensing	High Fixed; Sensitive (Pump establishes baseline and will alarm when pressure exceeds baseline)
Infusion Log	Stores all infusion setting from previous 2 infusions
Syringe Compatiblity	Accommodates all standard Becton-Dickinson, Monoject, and Terumo Syringes up to 60 ml
Plunger Capture Detection	Automatic
Syringe Size	Automatically displayed
Power	100-240 VAC ±10%, 50-60 Hz, 0.9 Amp; standard detachable, lockable IEC Hospital Grade line cord; Rechargeable Li-Ion Battery, 6+ hour capacity
Status Lights	Light under screen indicates current pump function: -Purge -Setup -Stop -Run -Bolus -AC Power On -Battery Charging
Dimensions, H x W x D	26 x 15.9 x 11.7 cm (10.3 x 6.2 x 4.6 in)
Weight	1.4 kg (3 lbs)

Catalog No.	$	Product
BS4 72-4290		Harvard 1 Syringe Pump
BS4 72-4291		Drug Library for Harvard 1

Harvard 2 Dual Pump with Occlusion Detection



- Two independent pumps in one case
- Occlusion and syringe capture detection improves safety and data integrity
- Clear color screen, pull down menus, and simple 'mouse like' data entry knobs provide exceptional ease of use
- Battery backup/operation up to 5 hrs
- Infusion log reduces data recording time
- Bi-directional serial communications
- Optional drug library
- Ideal for anesthesia

1. **Status Lights**
2. **Syringe Plunger Capture Mechanism**
3. **Backlit Color LCD Screen**
4. **Function Lights Indicate Pump Function Mode**
5. **Barrel Clamp Secures Syringe in Place**
6. **Barrel Clamp Paddle Opens Barrel Clamp for Easy Syringe Loading**
7. **Data Entry Knob: Used to Enter and Change Information**
8. **Function Knob: Controls Operation of the Pump**

Fifty years ago Harvard Apparatus invented the syringe pump. After extensive research and development, Harvard Apparatus now brings you the next generation of syringe pumps.

Two Independent Pumps in One

The Harvard 2 Syringe Pump features two independent syringe pumps in one housing. Each pump can flow at a separate rate, hold a different size syringe, infuse a different drug, and be connected to 2 different animals or infuse two different solutions into the same animal.

Each Pump Provides

- Accurate delivery of ±3% (excluding syringe variations)
- Flow rates from 0.01 to 1,200 ml/hr

Three infusion modes: Continuous, Continuous with Bolus, and Dose/Time (for a single volume limit infusion or intermittent infusions). Select from 16 different infusion units. (See specifications.)

Improved Safety

Occlusion Detection - Detection of occlusion has always been a problem when using infusion pumps. Today with the trend toward micro-infusion and the increased delivery of potent, fast-acting drugs, the importance of occlusion detection has increased. The Harvard 2 has a unique occlusion detection and pressure status message system that decreases the time to sense an occlusion. A bar graph illustrates the pressure build-up (can be displayed on the last line of all screens).

The Occlusion Alarm Limit can be set to 'Sensitive' or 'High-Fixed'. In 'Sensitive' Mode the pump samples the actual pressure in the system and displays it on the bar graph. The alarm pressure is set just above the measured pressure. In the 'High-Fixed' mode the pump will alarm when a fluid pressure of 17 p.s.i. (nominal) is reached.

Intuitive and Easy to Use

Large, Full Color LCD Screen - Easy to read even up to 6 feet away with a wide viewing angle. Colors displayed convey important information at a glance.

Setting up and using the Harvard 2 is fast, easy and accurate! Each pump is controlled using only 2 knobs: One for data entry and one for selecting the function.

Automatic Syringe Detection - The syringe size is automatically detected and displayed on the screen next to the syringe manufacturer. Simply press the data entry knob for positive confirmation. You will never have to measure a syringe diameter again!

Help Screens - *First Time Users* - By selecting 'Help', the pump provides a series of screens prompting entry of the necessary information.

Data Entry and Function Knobs - Both knobs rotate to scroll through options and are pressed to select the desired function.

- Data Entry Knob - Works similar to a computer mouse! Used to select data from pull-down menus and is also used to scroll through available flow rate units. Also used to change the flow rate and other numbers even when the pump is running.
- Function Knob - Five operating modes; Purge, Setup, Stop, Run, and Bolus can be selected. A simple LED indicates the selected mode. A two step confirmation process to start the pump insures safe accurate infusions.

Simple Syringe Loading - This pump will hold any syringe from 1 to 60 ml. To load, push the paddle down to open the barrel clamp. Insert the syringe and release the paddle. Now simply slide the pusher block down to the top of the syringe. It's that easy.

Harvard 2 Dual Pump with Occlusion Detection

Syringe Warnings

Syringe Not Captured - The pump will display a syringe icon if the syringe has not been loaded or has been loaded improperly.

Plunger Capture Detection - Audible and visual alarms that warn the users if the syringe plunger is not captured.

Near End of Syringe Warning - When there are 15 minutes remaining before the syringe has to be changed (when running at the displayed rate) the pump will display a warning message and will decrement the remaining time in minutes. Once the syringe is empty, it will sound an audible alarm.

Battery Backup/Operation

Battery Backup - Allows the pump to automatically switch into battery power mode.

Battery Operation - For remote use or when AC line noise could interfere with the experiment. Lithium battery provides 5 hrs of power. Recharges in 3 hours at 25°C.

Reduce Data Recording Time

Infusion History Log Reduces Data Recording Time - The pump details its operational history by keeping a log of the precise time and nature of all changes and alarms for the current and preceding infusion. The log can be viewed on the screen, printed, or downloaded to a monitor or electronic record-keeping system to simplify record keeping.

Communications

Bi-Directional Serial Communications - The Harvard 2 Syringe Pump can be controlled remotely from a computer for advanced infusion regimens. Conversely, infusion history can be downloaded to a monitor.

Drug Library Software

- Substantially reduces setup time
- Reduces Infusion errors
- The drug being infused is clearly indicated
- The minimum and maximum safety limits of the drug can be preset and infusions held within these limits

The Harvard 2 Syringe Pump has a Drug Library capacity for up to 300 drugs. These drugs can be stored in up to 50 categories.

The user-defined categories can be those most useful for the application: types of drugs like analgesics, cardiovascular or laboratory/researchers names.

For each of the 300 drugs, the Drug Library can store up to 3 concentrations, default units, infusion values, and minimum and maximum safety limits (which can be overridden by the researcher). The same drug can be listed in several different categories with each listing having different default values and safety limits.

The drug library also allows the user to develop a custom drug library for your own laboratory. This is done on your PC and uploaded to the pump via the RS-232 port and accessed at any time direct from the pump display.

Specifications

Number of Pumps	2 independent syringe pumps in the same housing for the delivery of 2 drugs simultaneously
User Interface	Display: 4 inch diagonal, backlit active matrix color LCD wide viewing angle user-adjustable brightness; green running, yellow warning, red alarms; screen divided vertically to display information for each pump
Infusion Units	µg/hr, µg/kg/hr, µg/min, µg/kg/min, mg/hr, mg/kg/hr, mg/min, mg/kg/min, g/hr, g/kg/hr, g/min, g/kg/min, U/hr, U/kg/hr, U/min, U/kg/min
Infusion Modes	Continuous Infusion, Continuous Infusion with Bolus Capability, Intermittent (Dose/Time) Infusion
Total Infused	Can be displayed in up to 3 sets of units, e.g. ml, µg, and µg/kg; can be set to zero any time
Drug Library	Uploadable to pump; requires Drug Library Software
Infusion Log	Details the operational history of the current and previous infusions for each pump by recording the date and precise time of all infusion and alarm events; can be displayed on screen, printed or downloaded to a computer
Bi-directional Serial Communications (RS-232 Interface)	Provides the ability to download data from the pump to a monitor, electronic record keeping system, workstation, computer or printer, remotely control the pump, or upload drug library data from the optional Drug Library Software Program
Sizes Accepted	1 to 60 ml
Infusion Rate	0.01 to 1200 ml/hr (dependent on syringe size), maximum rate can be limited
Bolus Rate	0.1 to 1200 ml/hr (dependent on syringe size)
Purging Volume	0.5 ml (1 to 10/12 ml syringes); 1.5 ml (20 to 60 ml syringes)
Syringe	Becton Dickinson Plastipak®, Luer-Lok® (B-D), Sherwood
Manufacturers	Medical Monoject® (MON), or Terumo® (TER)
Rate and Volumetric Accuracy	±2% excluding syringe variations
Occlusion	Adjustable; High-Fixed & Sensitive; Automatically set to 'High-Fixed'
Detection	For rates >50 ml/hr and while delivering Bolus and purging; Bar graph which indicates pressure in the line and pressure alarm limit can be displayed on last line of screen
Alarms	Syringe empty, Occlusion, Syringe plunger not captured, Syringe not in place, Pusher block has moved, Battery life 5 min, System fault
AC Power Supply	85 to 265 VAC, 50/60 Hz; universal input. Accepts a hospital grade line cord; provides filtration of the AC power input
Battery	Rechargeable lithium: hour life replaceable by biomedical engineer. Pump displays Battery icon with time remaining in hours and minutes. Internal recharge, 3 hr Recharge at 25°C.
Dimensions, H x W x D	260 x 213 x 137 mm (10.2 x 8.4 x 5.4 in)
Weight	2.8 kg (6.16 lb)
Orientation	Vertical when mounted to a pole or standing on a table (only for syringes < 60 ml) or lies flat on a tabletop

Catalog No.	$	Product
BS4 63-0321		Harvard 2 Dual Syringe Pump with Occlusion Detection
BS4 63-0322		Drug Library Software
BS4 63-0323		Calibration Kit

Note: This pump is sold for animal research only.

For Plastic Syringes, see pages A76 and A77.

Mechanical Syringe Pumps

Harvard Mechanical Compact Syringe Pumps

'975' Mechanical Compact Syringe Pumps

'2274' Mechanical Compact Syringe Pump

'975' and '2274' Features

- Infusion only
- Speed accuracy ±0.01%
- 30-speed mechanical gear box with positive locking action
- Ratio between adjacent settings has been held to only 1.4 to 1. The range over the 30-gear settings is 17,000 to 1
- A gear overload clutch stops pusher block advance when the required force exceeds 25 lbs.

'975' Mechanical Compact Syringe Pumps

This is the pump that built Harvard Apparatus' reputation for reliability and precision. The AC synchronous motor and gear box provide low flow rates and a complete absence of pulsation. Its synchronous motor is regulated by the supply line frequency giving the ultimate accuracy of ±0.01%. Its thirty speed mechanical gear box is an engineering marvel that will give years of service.

This pump's syringe holder can hold either one or two plastic or glass syringes of any size from 2 ml to 100 ml.

Two additional syringe holders are supplied and can be easily installed. The first will hold up to three 20 ml syringes and the second up to four 5 ml syringes.

Specifications

Type	Mechanical multiple-syringe; infusion only
Motor	30-speed
Syringe/Size:	Glass and plastic
Holder for up to 2 Syringes	2 ml to 100 ml
Holder for up to 3 Syringes	20 ml only
Holder for up to 4 Syringes	5 ml only
Dimensions, H x W x D	355 x 171 x 89 mm (14 x 6-3/4 x 3-1/2 in)
Weight	5.4 kg (12 lb)

Catalog No.	$	Model	Product
BS4 55-1689		975	115 VAC, 60 Hz
BS4 55-1697		975A	230 VAC, 50 Hz
BS4 55-1705		975B	115 VAC, 50 Hz

Flow Rate Ranges

'975' Flow Rate Syringe Volume	Low (µl/min)	High (ml/min)	'2274' Flow Rate Syringe Volume	Low (µl/min)	High (ml/min)
1 ml	0.074	1.347	10 µl	0.0000073	0.1260
3 ml	0.266	4.759	25 µl	0.0000182	0.3150
6 ml	0.541	9.601	50 µl	0.0000364	0.6300
12 ml	0.854	15.035	100 µl	0.0000730	1.2600
20 ml	1.416	24.721	250 µl	0.0001820	3.1500
35 ml	1.935	33.624	500 µl	0.0003640	6.3000
60 ml	2.424	41.981	1000 µl	0.0007300	12.6000

'2274' Mechanical Compact Syringe Pump

This pump is exactly like the '975' compact/syringe pump, see to the left, with these exceptions:

- The motor is 100 times slower
- Single syringe holder is supplied for holding one or two syringes from 10 µl to 50 ml

This pump is ideal for infusions into single cells.

Specifications

Type	Mechanical microliter multiple-syringe; infusion only
Motor	30-speed, 100 times slower than the Model '975' Pump
Syringe/Size	Up to 2 syringes; glass and plastic; 10 µl to 50 ml
Dimensions, H x W x D	356 x 152 x 89 mm (14 x 6 x 3-1/2 in)
Weight	5.4 kg (12 lb)

Catalog No.	$	Model	Product
BS4 55-3206		2274	115 VAC, 60 Hz
BS4 55-3214		2274A	230 VAC, 50 Hz

Did you know?

Harvard Apparatus now owns Clark Electromedical. See page M47 the Cell Biology Section for the industry standard capillary glass.

Pumps for Continuous Flow Applications 24/7

Applications:

- HPLC and LPLC
- Continuous calibration stream
- Large volume solvent blending

Benefits:

- High accuracy
- High precision
- High pressure
- Pulseless flow
- 2 year warranty on all HAI syringe pumps

Harvard Apparatus has three ways to solve your need to have a high precision syringe pump and continuous flow. This is important in applications where high precision, high accuracy and pulseless flow is necessary.

1. PHD 22/2000 Push-Pull Programmable

This is the simplest method to provide continuous flow for your application. The pump has a syringe holder that will mount syringes in apposing directions. Each pump will hold 4 syringes, two in one direction and two in the opposite direction. When the pusher block is moving in the forward direction, the forward facing syringes are dispensing while the oposite facing syringe are refilling. When the pusher block reaches the end of travel, the pump direction reverses so now the forward facing syringes are refilling while the opposite syringes are dispensing.

The PHD 22/2000 Push-Pull Pump programmble model offers the greatest flexibility in control because it allows you to program exactly the sequence of steps you want. It allows for continuous cycling. This Pump is also available in a remote model where the pumping mechanism is separated from the control box by a 30 foot cable.

The PHD 22/2000 Push-Pull Programmable is available in a high force model, up to 430 pounds of force, that are ideal if you are working with viscous fluids, see page A12 to A15 for complete pump details. We also have a special push/pull model that will hold up to 20 syringes, 10 in each direction. Please call for details.

2. Syringe Pump 33 Two Pumps in One!

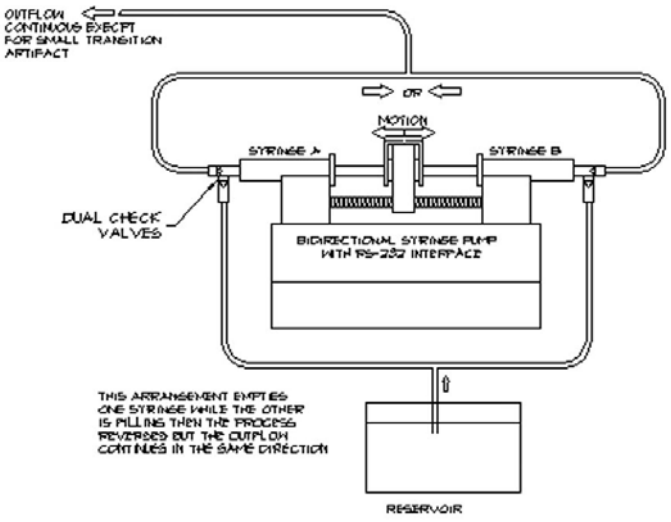
This amazing pump can do a variety of applications including continuous deliver and push pull style delivery. This pump has two independent motors. With the addition of a valve box you can have one syringe delivering while the other syringe is refilling. When the first syringe is empty the pump simply reverses direction and the second syringe will delivery while the first syringe refills. This pump can do this 24/7. See Harvard Pump 33 on page A11. We also have two special models of the Pump 33 that will hold a total of 4 or 8 syringes, 2 or 4 on each pumping mechanism, increasing your fluid pumping capacity.

3. RS232 Control Additional Equipment

In addition to the syringe pump a valve will be necessary to to provide continous delivery. We have many valving options to pick from. Select either passive or active valves. Select from high or low pressure Valves. We have ones with low dead space volume and/or high purity fluid paths.

Catalog No.	Product
BS4 61-0270	Continous Flow Tubing Segment for PHD 22/2000 Push/Pull Syringe Pump, 20 p.s.i.
BS4 55-1146	'Auto Fill' Valve, Normal Pressure, 30 p.s.i.
BS4 55-1146	'Auto Fill' Valve, High Pressure, 200 p.s.i.
BS4 55-3336	Syringe Pump 33 Continous Delivery Valve, Normal Pressure, 30 p.s.i.
BS4 55-3337	Syringe Pump 33 Continous Delivery Valve, High Pressure, 200 p.s.i.

Special high pressure valves are available that can tolerate up to 1,250 p.s.i., please call for additional information.



Syringe Pump Applications

Pumps for Continuous Delivery Applications

Applications:

- HPLC and LPLC
- Calibrating Mass Spec
  - Calibration made easy
  - Hands free with multiple injections
  - No more loading by hand
- Injecting fluid into different vials on a Fraction collector
  - Fully automate the proccess so all you need is to keep the reservoir full
- Controlled drug injections over time

Benefits:

- 24/7 delivery of calibrant
- Maximize syringe size for accuracy
- Reservoir is external

Continuous delivery is the process by which a specific volume is delivered multiple times. It may be a couple of deliveries or many deliveries over a long periord of time. The only requirement of the system is that the time delay between deliveries must be long enough for the syringe to refill.

This is different from continous flow where the fluid delivery is continuous over time. There are no "non-delivery periods" in continuous flow applications. Whether continuous delivery or continous flow, both require additional equipment in order to allow the syringe to refill.

There are two pumps that are ideal for continous delivery. They are two pump groups that are ideally suited to this type of application:

- PHD 22/2000 Programmable Push/Pull Syringe Pump
- Pump PHD 22/2000 Programmable Syringe Pump
- Dual Syringe Pump 33

The PHD Push/Pull and Dual Syringe Pump 33 allow a syringe(s) to be refilling while a syringe(s) is dispensing. This allows for multiple deliveries with minimal time between dispenses. The programmable pumps offer the advantage of being able to string together a sequence of steps so the delivery process becomes automated allowing the user to leave the pump unattended.

Using RS-232 for Continuous Delivery Applications

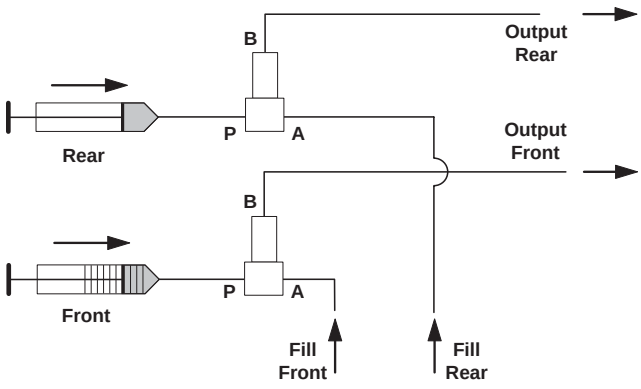
Another way to provide continous delivery is to control a syringe pump via an external computer. The RS232 port is used for that purpose. The Pump 11 Plus, Pump 11 Pico Plus, Harvard 33, Harvard 22 and all the PHD 22/2000 Syringe Pumps have this interface. The end user must write the computer control code that tells the pump what to do. Also note that the time between injections is limited by the speed at which the syringe can refill.

Additional Equipment

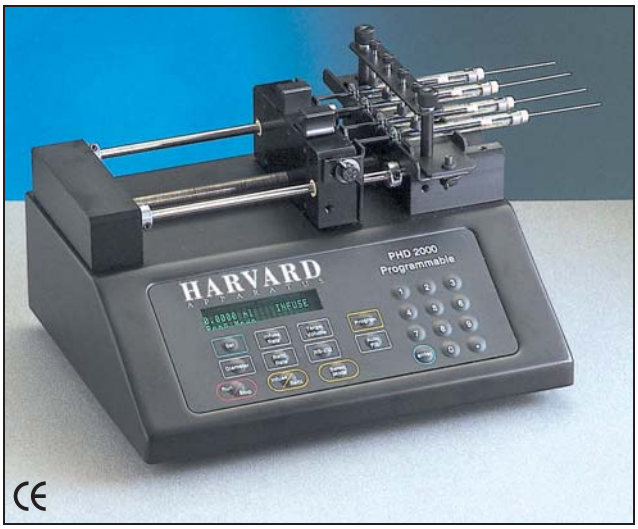
In addition to the syringe pump a valve will be necessary to provide continous delivery. We have many valving options to pick from. Select either passive or active valves. Select from high or low pressure Valves. We have ones with low dead space volume and/or high purity fluid paths.

Catalog No.	Product
BS4 61-0270	Continous Flow Tubing Segment for PHD 22/2000 Push/Pull Syringe Pump, 20 p.s.i.
BS4 55-1146	'Auto Fill' Valve, Normal Pressure, 30 p.s.i.
BS4 55-1146	'Auto Fill' Valve, High Pressure, 200 p.s.i.
BS4 55-3336	Syringe Pump 33 Continous Delivery Valve, Normal Pressure, 30 p.s.i.
BS4 55-3337	Syringe Pump 33 Continous Delivery Valve, High Pressure, 200 p.s.i.

Special high pressure valves are available that can tolerate up to 1,250 p.s.i., please call for additional information.



Pumps for Low Flow Applications

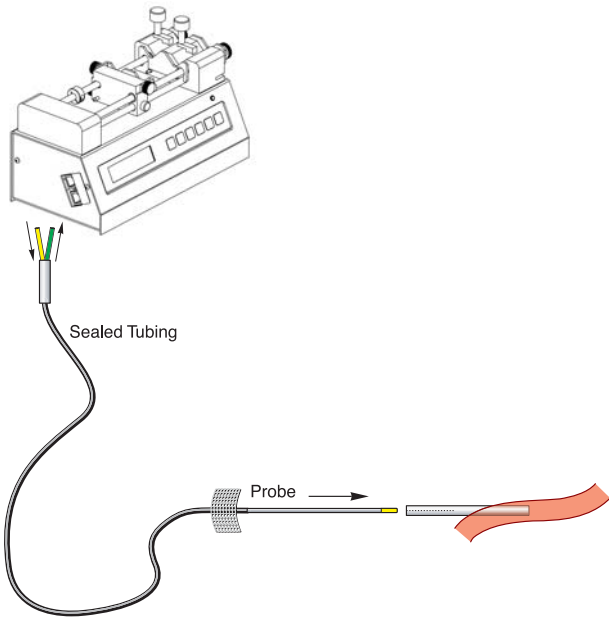


Applications

- Microdialysis
- Oocyte Cell Injection
- Micro Flow for FIA or Capillary LC
- Micro Reaction Deliver

Harvard Apparatus has long been producing syringe pumps that are ideal for low flow applications. These types of applications usually require a smooth, non-pulsatile flow that is extremely accurate.

Two pumps in the Harvard Syringe Pump family are perfectly suited to these types of applications.



11 Pico Plus Syringe Pump

The Harvard Pump 11 Pico Plus is perfectly suited for the low flow, high accuracy procedures requried for microdialysis and oocyte cell injection. This pump provides flow rates from 3.3 picoliters/minute up to 0.8788 milliliters/minutes. This pump can hold two syringes that need not be the same size. Each syringe is held by its own clamp. Different flow rates may be obtained by using two different size syringes should your application require it.

The lowest flow rate is achieved by using a microliter syringe. The highest flow rate by combining the output of two 10 millilter syringes. Cell injection is possible by using the included foot switch or by controlling the pump via the key pad or the RS232 interface. In addition to infusion this pump also offers withdrawal capabilities included.

PHD 22/2000 Syringe Pumps

The PHD 22/2000 family of pumps is the most versatile series of syringe pumps Harvard Apparatus offers. It is available in infusion only, infuse/withdraw and the advanced programmable model. Each of these is available with a variety of syringe racks. For low flow applications the microliter syringe rack will hold 4 syringes from 0.5 microliter to 10 milliliter. Like the 11 Pico Plus, each syringe is held by a individual clamp allowing removal or insertion of one syringe without disturbing another. Also different sized syringes may be held in the rack.

The PHD 22/2000 Syringe Pumps are also available in a high force models. This is why they are more suited to applications such as Micro Flow for FIA or Capillary LC Micro Reaction Delivery.

Syringe Pump Applications

Syringe Pumps for Mass Spectrophotometry

- Smooth, pulse-less flow
- High accuracy at low flow rates
- Systems for 24/7 delivery
- Pumps for automatic calibration

Applications

- Matrix delivery
- Calibration solution delivery
- 24/7 delivery of calibration solutions
- Delivery of sample

Harvard Apparatus is the leader in providing pumps for Mass Spectrometry applications. These syringe pumps offer a smooth, pulse-less flow at low flow rates with the high accuracy and precision needed to handle the varied needs of Mass Spectrophotometer.

The most widely used pump for Mass Spectrometry is the Harvard Apparatus Model 11 Plus. Harvard Apparatus makes other models that are also suitable for this application. These pumps are ideal for the applications listed above. Below are listed the pumps that we recommend for mass spec of applications:

Catalog No.	Product
BS4 70-2002	PHD 22/2000 Infuse/Withdraw Programmable with RS-232
BS4 70-2213	Syringe Pump 11 Pico Plus, Infuse/Withdraw with RS-232
BS4 70-2211	Syringe Pump 11, Infuse/Withdraw with RS-232
BS4 70-2212	Syringe Pump 11, Infuse/Withdraw with RS-232
BS4 70-2001	PHD 22/2000 Infuse/Withdraw with RS-232

The pumps are all infuse/withdraw models with RS-232 communication capabilities. The PHD 22/2000 Programmable Pump has the added benefit that allows you to program up to 10 steps directly from the pump and control a valve without the use of a PC. All the other pumps require RS-232 communications to control switching valves and 24/7 operation. For more details see Pumps for Continuous Flow or Pumps for Continuous Delivery on page A27 and A28 respectively.

Calibration Solution Delivery

Not only can your deliver samples automatically, you can also deliver a calibration solution automatically every hour, every day or every week. Use one of our Harvard Apparatus Pumps plus a valve and RS-232 communications. It is that easy. Use the PHD 22/2000 Programmable pump an it can be done directly from the keypad. This feature may be important so that you can maintain your ISO 9000, GLP or GMP compliance.

Matrix Delivery

Harvard Apparatus pumps are the ideal choice for your matrix delivery needs. When preparing a sample for injection into the mass spec system it is crucial that the correct amount of matrix is added to your sample. These pumps can precisely deliver the small amount of matrix you need so that your Maldi-TOF mixture is exactly what you want.

PHYSIO 22 - Low EF Syringe Pump for Physiological Experiments

These types of applications are particularly sensitive to electrical noise and therefore would benefit tremendously by using our new PHYSIO 22 Syringe Pump.

Some basic specifications are listed on this page. For complete details and specifications on this pump please see the Pump 22 Syringe Pump on page A10. This pump is currently available as infusion only with standard 2-syringe rack. An infuse/withdraw model is available by special order. Please call for details.

A spurious electromagnetic signal was recently found within the design of the Physio 22 which allowed the introduction of a small 50/60 Hz signal into a shielded environment. In particular, a small transformer within the Physio 22 generated an electromagnetic field which was sensed by an adjacent perfusion line. The problem was corrected by replacing the offending transformer with one incorporating toroidal architecture. This change in design successfully contains the stray electromagnetic field and renders the device electrically silent.

- Low EF noise
- Pulse less flow
- High accuracy

Applications

- Patch Clamping
- Oocyte applications
- Cellular injections

The PHYSIO 22 Pump delivers high accuracy, pulseless flow with no electrical noise to interfere with the sensor signal while performing physiological analyses. This specialty pump is based on our legendary Syringe Pump 22, but with a special toroidal transformer designed for minimum EF. This new transformer cuts electrical noise so that it is almost non existent.

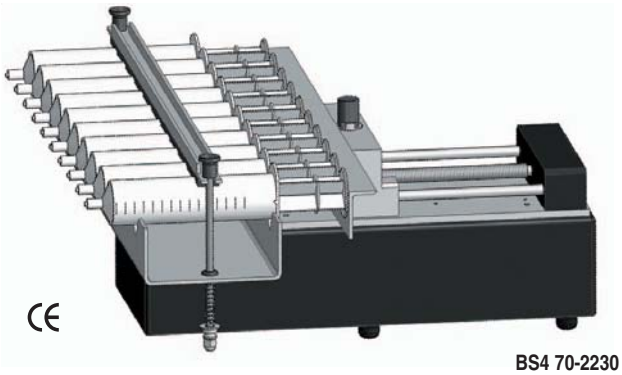
The electrical noise difference between our standard pump 22 and this new model is quite dramatic. Standard pumps generate a magnetic field which will induce a current into the conductive media coming out of the syringe. This will create noise in the biological reading/recordings. With the new PHSIO 22, even the most sensitive sensors will not show a noise spike. With the new toroidal transformer the noise disappears completely.

Specifications

Type	Microprocessor 2-syringe, infusion only
Accuracy	±0.35%
Reproducibility	±0.05%
Syringes Size:	
Minimum	0.5 µl
Minimum	140 ml
Flow Rate:	
Minimum	0.002 µl/hr
Maximum	55.1 ml/min
Voltage Range	95 to 130 VAC, 60 Hz; 220 to 260 VAC, 50 Hz, selectable
Dimensions, H x W x D	28 x 22.2 x 14 cm (11 x 8.75 x 5.5 in)
Weight	4.5 kg (10 lb)

Catalog No.	$	Product
BS4 70-2222		PHYSIO 22 Syringe Pump

NEW 10-Syringe Feeding System



BS4 70-2230

This 10-Syringe Feeding System is a convenient and versatile system providing a method to feed multiple animals simultaneously, making it ideal for multiple animal feeding studies or other applications which require precise parallel pumping. The standard syringe rack can hold up to 10 syringes ranging in size from 50cc to 140cc. You can use plastic or glass syringes. Other syringes sizes may be used. See pages A72 to A77 for a more complete listing of available syringes.

The Broad performance characteristics of the Feeding System make it ideal for small drug or large volume nutritional variables on large animal populations.

- High pressure
- Large flow rate range
- High reliability
- High accuracy and precision

This 10-Syringe Feeding Station is comprised of a PHD 22/2000 Hpsi Syringe Pump with 10-syringe multi-rack. The syringe pump has a 5 foot cable that connects the control box to the pumping mechanism box. If additional distance is required between the controller and pump, a remote extension cable is available as an accessory. For complete specifications on the syringe pump, see page A16.

Catalog No.	$	Product
BS4 70-2230		10-Syringe Feeding System
BS4 72-1405		Remote Control Cable for PHD 22/2000 Hpsi Syringe Pump, 9.1 m (30 ft)
BS4 72-1836		Hamilton Gas Tight Glass Syringe 50cc, Teflon Luer Lock Termination, pkg. of 1
BS4 72-1837		Hamilton Gas Tight Glass Syringe 100cc, Teflon Luer Lock Termination, pkg. of 1
BS4 72-2375		Monoject® Sterile Syringes, 60cc, Luer Lock Termination, pkg. of 20
BS4 72-2399		Monoject® Sterile Syringes, 140cc, Luer Lock Termination, pkg. of 20

For a more complete selection of available syringes, see pages A72 to A77.

Applications

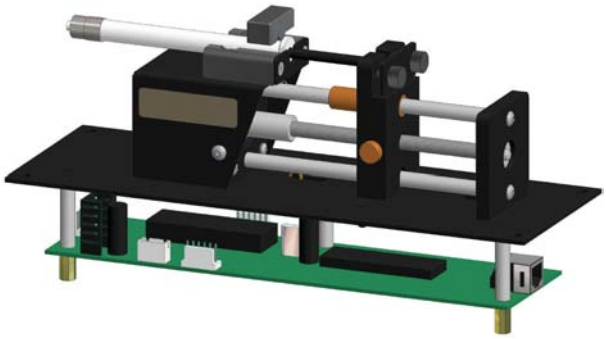
- Effects of dietary factors on large animal populations
- Dietary prevention of chronic diseases studies
- Diet and alcohol interactive effects on metabolic systems

Features

- 10 syringe capacity – mechanism can be modified to hold more syringes or smaller sized syringes
- High linear force pump - 433 pounds of force to move the syringe plungers
- Programmable flow rate with time or transducer response
- Flow rate range from 1.5 µl/hr to 112 ml/min
- Utilizes 50cc or 140cc plastic syringe or 50cc or 100cc glass (customs available)
- RS-232 and TTL communications
- Proven high reliability, can run 24 hour a day for weeks, 2 year warranty

For Harvard Pulsatile Blood Pump, see page A37

NEW Micro-Liter Syringe Pump Module



The new "µl" Pump Module is a low cost, highly precise, single syringe infuse/withdraw pump capable of low to moderate back pressures. It is available in one version only and will hold one syringe of any make from 0.5 µl to 1 ml. The diameter of the syringe and desired flow rate are entered via the RS-232 serial port, and the internal microprocessor drives a precision stepper motor to produce accurate fluid flow. This unit is designed to operate inside an enclosure, cabinet, or on top of a bench. The board may be removed for "remote" operation.

Two Modes of Operation - Constant Flow Rate and Volume Dispense

The "µl" Pump Module will operate continuously in RATE mode or accurately dispense a specific amount of fluid in VOLUME mode. When starting the pump, RATE mode will be the default mode. To operate in Volume mode, set a target volume and the pump will change modes to suit desired operation. This is the safest way to use the "µl" Modular Pumping. The pump will automatically stop when target volume is dispensed.

Smooth Flow

New micro-stepping pump profiles deliver very smooth and consistent flow.

Nonvolatile Memory

The pump remembers it's last syringe size, flow rate used and configuration settings in its non-volatile memory.

Location Requirements for the Syringe Pump

This pump module was designed to operate inside an enclosure, cabinet, or on top of a bench/table. The circuit board may be removed to a "remote" location if desired.

- A sturdy, level, clean and dry surface
- Minimum of one inch (2.5cm) clearance around the pump
- Adequate power supply
- Operating temperature 0° to 35°C (32° to 95°F)
- Relative humidity 20% to 80%

Protecting Small, Fragile Syringes

The "µl" Pump Module will hold microliter size syringes down to 0.5µl size. These small syringes have fine wire plungers that may be damaged if allowed to bottom out. The "µl" Pump Module is equipped with adjustable limit switches on the bottom side of the mounting plate. Make sure to adjust the limit switches to prevent damage to small syringes.

This Pump Module is supplied complete with the following components:

Component	Quantity
Syringe Pump Unit	1
DC Power Cable, 6 ft	1
Motor/Limit Switch Extension Cable, 6 ft	1
RS-232 Cable	1
User documentation	1
Grease, 6 oz. jar	1

- Low cost syringe pump!
- Ideal pump for do-it-yourselfers and OEM equipment designers
- Easy to incorporate legendary syringe pump technology into your equipment
- Precisely dispenses micro-liter volumes
- Smooth flow
- Nonvolatile memory
- Two modes of operation
  - Constant flow rate
  - Volume dispense
- Quantity discounts available on request

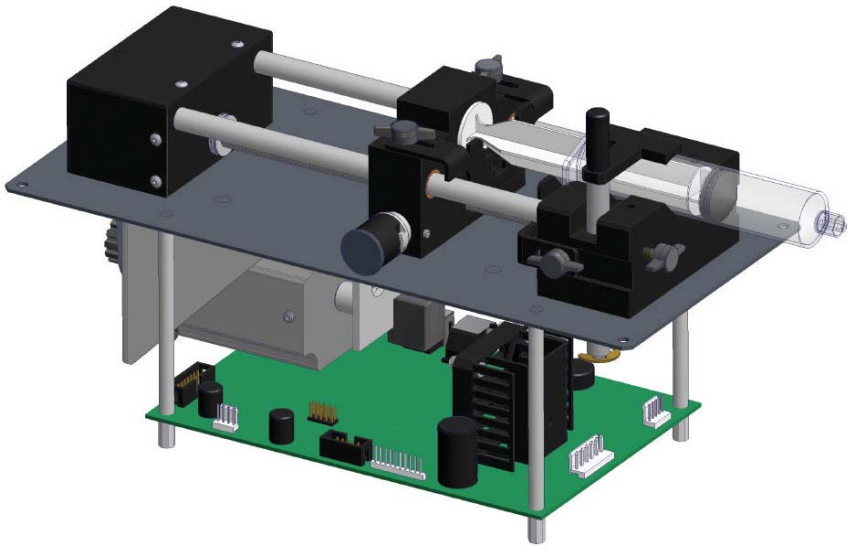
Specifications

Accuracy	±0.5%
Reproducibility	±0.1%
Type	Microprocessor single syringe, infusion/withdraw
Syringes	Holds 1 syringe made from either glass or plastic
Syringe Size:	
Minimum	0.5 µl
Maximum	1 ml
Flow Rate Range:	
Minimum	0.0014 µl/hr with 0.5 µl syringe
Maximum	0.854 ml/min with 1 ml syringe
Linear Force	6 lb, maximum
Display	None
Keypad	None
Interface	RS-232 with simple command language
Limit Switch	One for each direction (end of travel)
Drive:	
Motor	0.9° step angle motor
Control	L/R Drive, 0.75A per phase, 1/4 stepping
Drive Ratio	1:1 (Direct Drive)
Lead Screw Pitch	48 threads per inch (1/4-48)
Step Rate:	
Minimum	6.8 sec/step
Maximum	416.7 µsec/step
Pusher Travel Rate:	
Minimum	2.9 µm/min
Maximum	47.6 mm/min
Connectors:	
RS-232	4 pin RJ-11 telephone jack
DC Power	4-pin Header (Friction lock)
Power	+12VDC, 5%, 1A (12W) (User supplied)
Dimensions, H x W x D	11.4 x 23.5 x 8.3 cm (4.5 x 9.25 x 3.25 x 4.5 in)
Mounting Dimensions	22.2 x 7.0 cm (8.75 x 2.75 in) - Mounting holes for (4) #8 screws
Weight	0.84 kg (1.85 lbs)
Environmental:	
Operating Temperature	0 to +35°C (natural convection cooling)**
Storage Temperature	-20 to +70°C
Humidity	20 to 80% RH non-condensing

*** Note: operating temperature may be extended with forced air cooling*

Catalog No.	$	Product
BS4 70-2204		Micro-Liter Syringe Pump Module

NEW High Pressure Syringe Pump Module



- Easy to incorporate legendary syringe pump technology into your equipment
- Ideal high force syringe pump for do-it-yourselfers and OEM equipment designers
- Precisely dispenses volumes at high pressure
- Smooth flow
- Nonvolatile memory
- Three modes of operation:
  - Constant flow rate
  - Volume dispense
  - Programmable
- Quantity discounts available on request

The High Pressure Syringe Pump Module employs a microcontroller which controls a small step angle stepping motor that drives a lead screw and Pusher Block. Microstepping techniques are employed to further reduce the step angle, eliminating flow pulsation. Data can be entered via an RS-232 connector located on the micro controller. The microcontroller calculates the cross-sectional area of the syringe selected and calibrates the flow rate and volume accumulation. The numerous features of the High Pressure Pump Module result from the use of microprocessor technology.

The High Pressure Programmable Pump Module model provides full programmability along with Infuse/Withdraw capability. This unit is designed to operate inside an enclosure, cabinet, or on top of a bench. The board may be removed for "remote" operation.

Pressure and Speed

The High Pressure Pump Module can deliver up to 220.82ml/minute with a single 140ml syringe. Maximum pressure is dependent on syringe size. Drive produces >200 lbs linear force.

Infusion and Refill Rates

Specify independent rates for infusing and refilling. This allows a slow infusion rate then a fast refill.

Target Volume

Specify the volume that is to be infused or refilled. The pump will run at the rate specified until this volume has been delivered when in the Volume mode.

Auto Fill

Auto Fill automatically activates an externally attached solenoid (refer to Appendix L for part number) and refills the syringe when it is empty. This permits infusions to be virtually independent of syringe capacity.

Modes of Operation

(Set for pump mode, can be changed thru RS-232)

Pump: Runs continuously in the infuse or refill directions until stopped.

Volume: Runs until a specified volume has been pumped or refilled.

Program: Pump operates according to specified sequence of instructions.

(Note: All modes interact with Auto Fill)

External Connections User I/O

Allows pump operations to be synchronized with external devices or by a person at a distance from the pump. Connector pins are available to control direction of pump travel to control an external valve for refilling, and for general use. A simple contact closure to ground or TTL level signals may be used for inputs.

RS-232

Multiple pumps can be 'daisy chained' together and remotely controlled from a computer or any device communicating via RS-232.

A scale can be connected, enabling the pump to infuse by weight instead of by volume.

A printer can be connected to record final volumes or weights whenever the pump stops. In addition the program entered for the program mode can be listed on a connected printer. Both a scale and a printer may be connected simultaneously.

Non-Volatile Memory

All operational data entered into the pump from a computer will be stored, including the program.

Stall Detection

An optical detector is used to verify expected movement of the motor. If the motor is prevented from turning due to jamming or excessive back pressure, the pump will stop.

Program Storage

Programmable model can store up to 4 sets of 9 program sequences for later selection.

Infuse Rate

The Infuse Rate is the rate of pumping while infusing in the Pump or Volume modes.

Target Volume

The Target Volume is the volume that you desire to deliver at the set Infuse or Refill Rate.

NEW High Pressure Syringe Pump Module

Auto Fill

When set to 'ON', the syringe is assumed to be empty. Auto Fill continuously monitors the volume of the syringe according to the volume pumped. When the pump determines that the syringe is empty, the operation in progress is suspended and Auto Fill is activated. The pumping direction is then reversed and the pump runs at the refill rate.

Program Description

The programming functions of this pump provide powerful capabilities for advanced experiments. While in program mode this pump can perform the following tasks at a predetermined time or when prompted by a signal from an external device:

- start or stop pumping
- change pumping direction (infuse-withdraw)
- change flow rates
- pump a precise volume and stop
- pause operation
- ramp up or down flow rates

In program mode the above tasks can be linked together into powerful programs to simplify your automation projects.

This Pump Module is supplied complete with the following components:

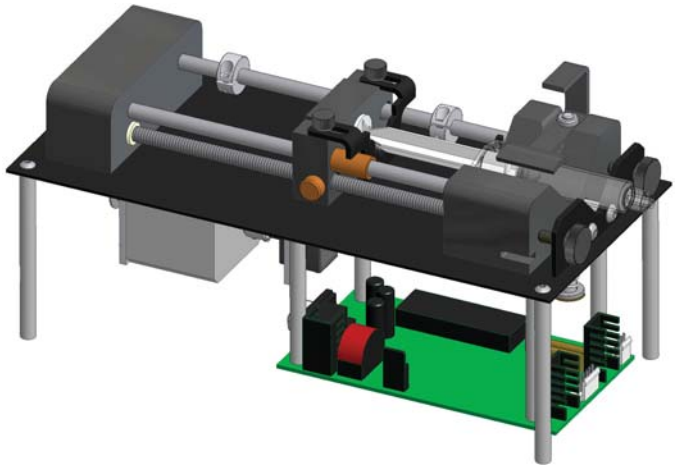
Component	Quantity
Main Unit	1
Motor/Encoder Extension Cable, 6 ft.	1
DC Power Extension Cable, 6 ft.	1
RS-232 Cable	1
Symphony Program Diskettes	1
Grease, 6 oz. jar	1

Specifications

Accuracy	±0.5%
Reproducibility	±0.1%
Syringe Sizes:	
Minimum	0.5 µl
Maximum	140 ml
Flow Rate:	
Minimum	0.001 ml/hr with 0.5 µl syringe
Maximum	220.82 ml/min with 140 ml syringe
Linear Force	200 lbs maximum
Drive:	
Motor	1.8˚ stepper
Control	Constant Current (Chopper) Drive, 2A per phase (max.), microstepping (from 1/2 to 1/32)
Pulley Ratio	2:1 (1:2 optional)
Lead Screw Pitch	24 threads per inch
Step Rate:	
Minimum	27.3 sec/step
Maximum	416.7 msec/step
Pusher Travel Rate:	
Minimum	0.18 mm/min
Maximum	190.676 mm/min
Display	Optional 2x20 Line VFD (p/n 2400-235)
Keypad	Optional (p/n 2400-252)
Interface	RS-232
Connectors:	
DC Power	4-pin Header (Friction Lock – Molex or AMP)
RS-232	4-pin RJ-11 Telephone Jack
User I/O	9-pin D-Sub Female
Power	+12 to +40VDC, ±5%, 75W (user supplied)
Environmental:	
Operating Temperature	0 to +35°C (natural convection cooling)**
Storage Temperature	-20 to +70°C
Humidity	20 to 80% RH non-condensing
Dimensions:	
Overall, H x W x D	16.8 x 14.0 x 30.2 cm (6.625 x 5.50 x 11.875 in)
Mounting	28.9 x 12.7cm (11.375 x 5.00 in), mounting holes for (4) #8 screws
Control Board Mounting	11.43 x 17.78 cm (4.50 x 7.00 in), mounting holes for (4) #6 screws
Weight	3.86kg (8.5 lbs)

Catalog No.	$	Product
BS4 70-2202		High Pressure Syringe Pump Module

NEW Milliliter Syringe Pump Module



- Low cost syringe pump!
- Ideal pump for do-it-yourselfers and OEM equipment designers
- Easy to incorporate legendary syringe pump technology into your equipment
- Precisely dispenses milliliter volumes
- Smooth flow
- Nonvolatile memory
- Two modes of operation
  - Constant flow rate
  - Volume dispense
- Quantity discounts available on request

The new "ml" Pump Module is designed as a low cost, highly precise, single syringe infusion pump capable of low to moderate back pressures.

There is only one version of the "ml" Pump Module available at this time. A dual "ml" Pump Module version can be produced upon customer request. Typically, the "ml" Modular Pumping Component holds one syringe of any make, from 0.5µl to 60ml. The diameter of the syringe and desired flow rate are entered via your PC, and the internal microprocessor drives a precision stepper motor to produce accurate fluid flow. This unit is designed to operate inside an enclosure, cabinet, or on top of a bench. The board ay be removed for "remote" operation.

Two Modes of Operation - Constant Flow Rate and Volume Dispense

The "ml" Pump Module will operate continuously in RATE mode or accurately dispense a specific amount of fluid in VOLUME mode. When starting the pump, RATE mode will be the default mode. To operate in Volume mode, set a target volume and the pump will change modes to suit desired operation. This is the safest way to use the "ml" Modular Pump. The pump will automatically stop when target volume is dispensed.

Smooth Flow

New micro-stepping pump profiles deliver very smooth and consistent flow.

Nonvolatile Memory

The pump remembers it's last syringe size, flow rate used and configuration settings in its non-volatile memory.

Location Requirements for the Syringe Pump

This pump module was designed to operate inside an enclosure, cabinet, or on top of a bench/table. The circuit board may be removed to a "remote" location if desired.

- A sturdy, level, clean and dry surface
- Minimum of one inch (2.5cm) clearance around the pump
- Adequate power supply
- Operating temperature 0° to 35°C (32° to 95°F)
- Relative humidity 20% to 80%

This Pump Module is supplied complete with the following components:

Component	Quantity
Syringe Pump Unit	1
RS-232/DC Power Cable, 6 ft	1
Motor/Limit Switch Extension Cable, 6 ft	1
User documentation	1
Grease, 6 oz. jar	1

Specifications

Accuracy	±0.5%
Reproducibility	±0.1%
Type	Microprocessor single syringe, infusion/withdraw
Syringes	Holds 1 syringe made from either glass or plastic
Syringe Size:	
Minimum	0.5 µl
Maximum	50/60 ml B-D Plastic
Flow Rate Range:	
Minimum	0.0014 ml/hr with 0.5 µl syringe
Maximum	26.56 ml/min with 50/60 ml syringe
Linear Force	25 lbs, peak
Display	None
Keypad	None
Interface	RS-232 with simple command language
Limit Stop	End of limit travel mechanical stop
Drive:	
Motor	0.9° step angle motor
Control	L/R Drive, 0.75A per phase, 1/4 stepping
Drive Ratio	2.4:1
Lead Screw Pitch	1/4 • 20 threads per inch
Step Rate:	
Minimum	6.8 sec/step
Maximum	416.7 msec/step
Pusher Travel Rate:	
Minimum	2.9068 mm/min
Maximum	47.6 mm/min
Connectors:	
RS-232/Power	9-pin D-sub
Power	+15 to +40VDC (12W min) (user supplied)
Dimensions, H x W x D	13.5 x 24.1 x 10.8 cm (5.3 x 9.5 x 4.25 in)
Mounting Dimensions	22.9 x 9.5cm (9.0 x 3.75 in) - Mounting holes for (4) #8 screws
Weight	1.27 kg (2.8 lbs)
Environmental:	
Operating Temperature	0 to +35°C (natural convection cooling)**
Storage Temperature	-20 to +70°C
Humidity	20 to 80% RH non-condensing

*** Note: operating temperature may be extended with forced air cooling*

Catalog No.	$	Product
BS4 70-2203		Milliliter Syringe Pump Module

Harvard Apparatus Pulsatile Blood Pumps

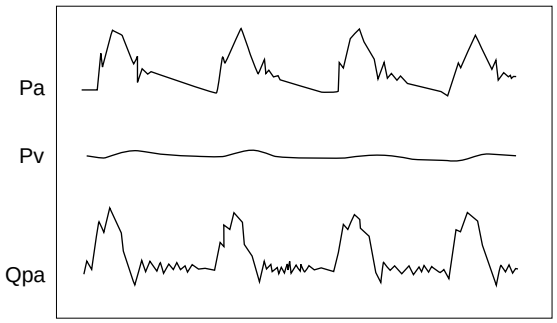
- Pulsatile output truly simulates the ventricular action of the heart
- Minimal hemolysis
- Models for mice to large animals
- Ideal for moving emulsions, suspensions, and non-Newtonian fluids such as blood

If you are performing cardiovascular work, this is the pump for you. It truly simulates the pumping action of the heart. It features silicone rubber-covered heart-type ball valves and smooth flow paths which minimize hemolysis. Only inert materials like silicone rubber, acrylic plastic, and Teflon contact the fluid. The pumping head is easy to take apart and reassemble and can be sterilized.

Outstanding Performance

The pulsatile output closely simulates the ventricular action of the heart. This action provides physiological advantages in blood flow for perfusion in cardiovascular and haemodynamic studies. It is ideal for isolated organ perfusion, whole body perfusion, blood transfers, hydration/dehydration procedures, and blood cellular profile studies.

Pressure and Flow Curves Using Harvard Model 1421 Pulsatile Blood Pump in Isolated Perfusion of Left Lower Lobe of Dog Lung*



Pa	Pulmonary	Artery	Pressure
Pv	Pulmonary	Venous	Pressure
Qpa	Pulmonary Artery Blood Flow		
Instrumentation:			
Pressure	Statham		
Flow	Biotronex Electromagnetic Flowmeter		
Recording	Electronics for Medicine		

**Note: The above data is supplied through the courtesy of Cardiorespiratory laboratory Columbia-Presbyterian Medical Center New York, New York, Dr. Alfred P. Fishman, Director.*

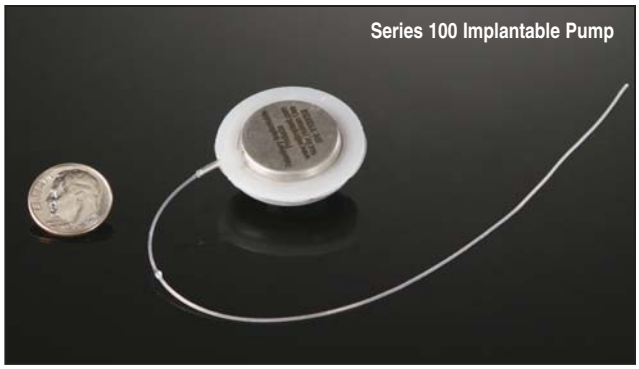
Pump Mechanism

A positive piston actuator and ball check valves provide the proportioning action. The product of stroke rate times stroke volume is an accurate indicator of the flow rate. Positive piston action prevents changes in flow rates, regardless of variations in resistance or back pressure. The piston always travels to the end of the ejection stroke, independent of the volume pumped. The Pump completely empties at each cycle.

Harvard Apparatus Pulsatile Blood Pump

Specifications	Mice/Rats	Rabbits	Dogs/Monkeys	Large Animals; Hemodynamic Studies
Stroke Volume, Adjustable	0.05 to 1.0 ml	0.5 to 10 ml	4 to 30 ml	15 to 100 ml
Rate, Stroke/Min.	20 to 200	20 to 200	20 to 200	10 to 100
Minute Volume, Stroke Vol. x Rate	1 to 200 ml	5 to 2,000 ml	80 to 6,000 ml	150 to 10,000 ml
Phasing	Fixed Phase	Fixed Phase	Adjustable Phase	Adjustable Phase
Systole/Diastole Ratio	35% systole, 65% diastole	35% systole, 65% diastole	35% to 50% of total cycle	35% to 50% of total cycle
Tube ID	8 mm (.31 in)	8 mm (.31 in)	13 mm (.5 in)	15.9 mm (.625 in)
Dimensions, H x W x D	312 x 156 x 250 mm (12.5 x 6.25 x 10 in)	312 x 156 x 250 mm (12.5 x 6.25 x 10 in)	500 x 212 x 337 mm (20 x 8.5 x 13.5 in)	500 x 212 x 337 mm (20 x 8.5 x 13.5 in)
Weight	7.3 kg (16 lb)	7.3 kg (16 lb)	13.6 kg (30 lb)	32 lb (14.5 kg)
Voltage	115/230 VAC, 50/60 Hz	115/230 VAC, 50/60 Hz	115 VAC, 60 Hz	115 VAC, 60 Hz
Catalog No.	**BS4 52-9552**	**BS4 55-1838**	**BS4 55-3321**	**BS4 55-3305**
$				

NEW Implantable Infusion Pumps



- Completely Implantable
- Refillable
- Innovative suture band
- Wide range of reservoir volumes and flow rates
- Immune to ambient pressure changes
- Minimally sensitive to changes in ambient temperature
- Start drug delivery at any time
- Enables verification of amount of drug delivered
- Functions as either an implantable or portable external unit
- Crematable

These Implantable Infusion Pumps have been designed to be accurate, versatile, and easy to use. The pumps are available in a range of reservoir sizes and with a wide range of flow rates to give you maximum flexibility in designing your studies. Some of the features of these pumps are not available on any other implantable pumps.

The pump is filled by percutaneously accessing the pump's refill septum. Once filled, the pump will continuously deliver fluid at a substantially constant, factory-set flow rate without any operator intervention until the pump is empty. Drug infusion can be stopped at any and drug delivery can be verified at any time by percutaneously accessing the pump reservoir and observing the volume of infusate remaining in the reservoir.

These pumps are fully implanted devices, and they have no external connections. This enables animals to be co-housed and reduces the chance of infection. This feature reduces the need to monitor subjects, and can eliminate the need for repeated nighttime or weekend dosing.

These Implantable Pumps incorporate a pre-attached pump outlet catheter and have been used for the intravenous, intra-arterial, intraintestinal, intraspinal, intraventricular, intra-articular, intraperitoneal, intraocular delivery of a variety of fluids. Subcutaneous infusion is not recommended.

Series 100

Series 100 pumps have 1 ml reservoir capacity. Although they can be used for animals of any size (>150 g) they are particularly appropriate for implantation in small animals, such as rats. The pumps are available in a range of nominal flow rates from 0.75 ml/24 hr (one day flow period) to 0.040 ml/24 hr (25 day flow period). In Series 100 pumps, the diaphragm functions as the fill septum, pressure source, and front wall of the pump reservoir. The pumps can be percutaneously refilled at least 100 times.

Series 2500

Series 2500 pumps have 25 ml reservoir volume and are designed for use on larger animals. They have been used successfully in animals as small as rabbits (>4 kg), and as large as livestock. The pumps are available in a range of nominal flow rates from 18.75 ml/24h (one day flow period) to 0.50 mL/24hr (50 day flow period). These pumps can be percutaneously refilled at least 500 times.

Note: Nominal flow rates are quoted for water at 37°C with no backpressure. Infusate viscosity, temperature, and backpressure affect the pump flow rate.

Specifications

	Series 100	Series 2500
Animal	Rats (> 150 g) and larger	Rabbits (> 4 kg) and larger
Power Source	Diaphragm	Diaphragm
External Dimensions, (Dia. x H)	25 x 6 mm	75 x 25 mm
Weight (empty)	5 g	120 g
Usable Volume	1 ml	25 ml
Reservoir Pressure:		
PSI	4	8
Bar	0.27	0.55
Refill Septum:		
Compatible Needles (max size)	26 G	22 G
Needle Type	Hypodermic	Non-coring
Puncture Life* (min punctures)	200	500
Internal Filter Pore Size	0.2	0.2

** Rated with compatible needles. Incompatible needles will reduce septum puncture life.*

Catalog No.	$	Flow Rate	Flow Period
Series 100 Continuous Flow Implantable Infusion Pump, pkg. of 5			
BS4 72-4245		0.10 ml/day	10 Days
BS4 72-4246		0.75 ml/day	1 Day
BS4 72-4247		0.40 ml/day	2 Days
BS4 72-4248		0.25 ml/day	4 Days
BS4 72-4249		0.17 ml/day	6 Days
BS4 72-4250		0.06 ml/day	17 Days
BS4 72-4251		0.04 ml/day	25 Days
Series 2500 Continuous Flow Implantable Infusion Pump, pkg. of 1			
BS4 72-4605		18.75 ml/day	1 Day
BS4 72-4606		10.0 ml/day	2 Days
BS4 72-4607		6.25 ml/day	4 Days
BS4 72-4608		4.25 ml/day	6 Days
BS4 72-4609		2.50 ml/day	10 Days
BS4 72-4610		1.50 ml/day	17 Days
BS4 72-4611		1.00 ml/day	25 Days
BS4 72-4612		0.75 ml/day	33 Days
BS4 72-4613		0.50 ml/day	50 Days

NEW Compatibility Kit for VIP™ Implantable Pumps

VIP™ Compatibility Kits enable the compatibility of the infusate and pump to be confirmed in vitro before initiating an in vivo study. Doing so enables the collection of baseline data and the identification of potential problems before spending time and money initiating a full-scale in vivo study. The test is performed in two phases.

Phase 1

The objective of Phase 1 is to confirm the compatibility of the pump and infusate. Materials used in the construction of the pump are commonly used in implantable device construction. Nonetheless, novel molecules have the potential to react with these materials in unpredictable ways. It is therefore prudent to confirm the compatibility in vitro.

To perform Phase 1 of the test, aliquots of the infusate are incubated for up to four weeks. Vials are prepared with and without the materials used in pump construction, and incubated at temperatures of 4ºC and 37ºC. The vials are inspected at regular intervals for obvious signs of component/infusate incompatibility such as precipitation or cloudiness, and for material degradation.

Phase 2

After the test infusate has passed the in vitro compatibility test, the Phase 2 in vitro flow test can be conducted. The objective of Phase 2 is to establish the expected infusion rate for the test infusate and to allow the assay of a series of aliquots after they have passed through the pump flow mechanism. This is achieved by using a modified Series 100 pump with a collection vial at the catheter tip.

To perform Phase 2, the test infusate is pumped from a calibrated Series 100 pump into a collection vial. The actual infusate flow rate is calculated, and the infusate that has passed through the pump flow mechanism is collected and assayed. This test phase yields two important pieces of information:

1. Viscosity Factor: This determines the effect the viscosity of the infusate will have on the pump flow rate. This information is important for determining the pump (water) flow rate to order to ensure the desired (infusate) flow rate is achieved in the experiment.
2. Extent of degradation of bioactivity: Phase 1 provides information about any degradation of bioactivity caused by temperature or material incompatibility. Phase 2 provides information about the cumulative effect of temperature, material incompatibility, and the effects of the pumping mechanism. By having these two pieces of information, it is possible to isolate the cause of the degradation, and to estimate the extent to which this factor must be compensated for in the experimental design.

Conducting these simple tests prior to initiating the in vivo study can identify a range of problems that would be costly and time-consuming to identify after the fact.

Catalog No.	$	Product
BS4 72-4614		Compatibility Test Kit for Implantable Pumps

NEW Specialty Catheters with Integral Bone Anchors

- Enables fluid delivery or sampling from the synovial capsule
- Enables fluid delivery or sampling from inside any boney cavity, e.g., cranium
- Easy to implant
- Compatible with Implantable Pumps and Access Ports

These specialty Catheters enable access to a variety of delivery sites. The Intra-articular Catheter is a unique silicone rubber and polyacetyl catheter that permits long-term access to the synovial capsule through a hole drilled in the surrounding bone. Because access is gained through the bone, the integrity of the synovial capsule is maintained. An analogous technique also can be used for intracranial applications with the Intracranial Catheter.

These Catheters may be attached to an Implanted Pump for continuous infusion, or to an Implanted Access Port for sequential bolus injections, external pump infusion, or repeated withdrawal or monitoring of fluids.

Catheters are shipped in kits and are non-sterile. The kits contain everything you need to place the catheter, including: a hand drill to drill the access hole; polyacetyl wrench to install the catheter tip; and 63 cm catheter segment. The catheters are supplied individually.

Specifications

	Intracranial	Intra-articular
Catheter:		
Materials	Silicone	Silicone
ID	0.25 mm	0.25 mm
OD	1.27 mm	1.27 mm
Length	63 cm	63 cm
Tip Design	Open, 8 holes, 0.38 m ID spaced at 2.5 mm intervals from tip	
Tap:		
Materials	Polyacetyl	Polyacetyl
Screw Diameter	3.2 mm	3.2 mm
Length, Tap Head to Catheter Tip	41.4 mm	47.6 mm
Length, Tap	9.5 mm	15.9 mm
Length, Tap Head	3.2 mm	3.2 mm

Catalog No.	$	Product
BS4 72-4616		Intracranial Catheter, pkg. of 1
BS4 72-7630		Intra-articular Catheter, pkg. of 1

Centrifugal Pumps for Blood

- Low hemolysis
- Flow rates up to 16 L/min
- No or only low pulsation
- Smooth run, producing only low noise
- Pump heads interchangeable without tool
- Speed setting by a digital switch in 0.1% steps
- "Max Speed" button for quick fill or ventilate
- Robust construction for long life time
- Analoge interface for remote control

The centrifugal pump is specifically designed for pumping blood and/or erythrocyte suspension solutions in the physiological or pharmacological laboratory. It consists of the pump drive BVP-ZX and a centrifugal pump head which can be replaced without tools. Pump heads are hermetically sealed. The coupling to the motor of the pump drive is carried out via magnetic force; there is no axle.

The pump speed is set using a 3-digit potentiometer switch (000 to 999) or via an analog interface.

The drive is very robust and suitable for continuous speed selection operation.

The pump drive and pump heads must be purchased separately. The pump heads are interchangeable and do not require tools to change.

Specifications

Pump Drive

Type	BVP-ZX
Speed	3 to 3000 rpm, adjustable in 0.1% steps
Mains Connection	230 (50/60Hz) 115 V (50/60Hz)
Power Consumption	120 W maximum
Analog Interface	Speed control 0–5 V or 0–10 V or 0–20 mA or 4–20 mA, start/stop (TTL contacts)
Protection Rating	IP 30
Operating Conditions	0˚ to 40 ˚C (normal environmental conditions)
Dimensions, H x W x D	260 x 155 x 260 mm (10.2 x 6.1 x 10.2 in) without pump-head
Weight	7 kg (15.4 lbs) without pump head

Centrifugal Pump Heads

Type	**BP-80**	**BP-50**	**SP-45**
Manufacturer	Medtronic	Medtronic	Terumo
Pump Technologies	Centrifugal	Centrifugal	Impeller (Centrifugal)
Maximum Flow Rate	10 l/min at 50 mmHg	–	16 l/min at 50 mmHg
	3 l/min at 300 mmHg	–	13 l/min at 300 mmHg
Pulsation	no	no	yes
Priming Volume	80 ml	50 ml	45 ml
Inlet/Outlet ID	9.5 mm	6.4 mm	9.5 mm
Fitting to BVP-ZX	Direct	Direct	Adaper SP 03 Required

Catalog No.	$	Product
BS4 73-2470		BVP-ZX Centrifugal Pump 230VAC
BS4 73-2963		BVP-ZX Centrifugal Pump 115VAC
BS4 73-2807		BP-80 Pump Head
BS4 73-2954		BP-50 Pump Head
BS4 73-2955		SP-45 Pump Head
BS4 73-2956		SP-03 Adaptor for SP 45 Head

Choosing the Right Peristaltic Pump

- Broad selection of pumps for every application
- Wide range of flow rates ml/hr to L/min
- Multiple multi-channel models with up to 32 channels
- Peristaltic and non-peristaltic pumps
- Continuous delivery and batch mode dispensing

Harvard Apparatus now offers an extensive selection of peristaltic and other continuous flow pumps to suit the needs of a wide range of research applications. Pumps which offer features such as multi-channel pumping, computer control, analog control, low electrical noise and a wide range of fluid flow rates are now available. Pump styles include traditional roller type peristaltic pumps, our exclusive double linear sinusoidal peristaltic pump, shuttle pumps which utilize check valves, and diaphragm pumps. The following and table was designed to answer most questions regarding our continuous flow pumps. Please contact our customer service department for further assistance.

We have added a large number of other peristaltic pumps as well. For complete details and specifications, see pages A45 to A59. We were unable to include these pumps in the chart below.

Peristaltic and Continuous Flow Pumps

Traditional peristaltic pumps utilize a series of rollers (1 to 8) to push fluid through tubing held within a pump head. Peristaltic flow is typically pulsatile, but can be made smoother with the use of more rollers in the pumping head. Our unique 1200 series pumps feature an arrangement of cam driven plates which move in a sinusoidal fashion to reduce pulsation. Each side of the double linear pump head design is exactly 180° out of phase. Ganging the output of both sides reduces the pulsation to levels unachievable with roller pumps, see page A68. Our newly redesigned Mini-Peristaltic Pump (MPII, see page A42) features two speed ranges, reversability and dual channel pumping at a very reasonable price. We have also added a microprocessor controlled diaphragm pump to our continuous flow line. Since no tubing is used within the pump head no changes in fluid flow rates occur as a result of tubing wear. This diaphragm pump offers reliable and reproducible continuous fluid transfer for extended periods of time and comes in standard and aggressive fluid models to accommodate a wide range of fluids, see page A91. Many pumps offer external control either through the input of an analog signal proportional to the speed or by RS-232 (serial) communication.

Pump Comparison Chart

Pump	MPII	66	77	1200	TPM	DPM	MPL	720	Shuttle	STEPDOS
Models Available	1	1	1	3	6	1	8	3	1	2
Channels	2	1	1	1 to 22	1 to 5	1	1 to 32	1 to 2	2	1
Number of Rollers	3	3	3	13(A)	2-8	2	8	3	1	
Flow Rate (ml/min/Per Channel):										
Minimum	0.8	0.01	0.01	0.00013	0.1	0.1	0.6	0.02	1.25	0.08
Maximum	24.5	210	750	1140	2200	300	22	3.0	50	80
Tube Size:										
OD (in)	1/8	1/16 to 1/8	1/8 to 1/4	1/8 to 3/8	0.0825 to 7/16	0.0825 to 7/16	0.0675 to 0.01725 (B)	0.015 to 0.093 ID (B)	(B)	1/4 - 28 UNF Thread
Wall Thickness (in)	1/32	1/16	1/16	1/32 to 1/16	1/16	1/16	1/16	(B)	(B)	
Computer Control		•	•							•
Analog Control							•	•		
TTL Control		•	•			•	•			
Diaphragm										•
Reversible	•	•	•	•		•	•	• (C)		
Accuracy (D)	NA	±1%	±1%	NA	±1%	0.5%	0.5%	NA	NA	±2%
Repeatability (D)	±3%	±1%	±1%	±1%	±1%	±1%	±1%	±3%	±3%	±2%
see page:	A42	A43	A43	A68 - A69*	A64	A65	A66	A42	A44*	A91

(A) Cam Operated Nylon Plates
(B) Special Tube Sets Required
(C) Reversible with analog control only
(D) Experimental setup and tubing properties may result in lower accuracy and repeatability
** Page number in our Full-Line Bioscience Catalog*

Peristaltic Pumps

Harvard MPII Mini-Peristaltic Pump

BS4 70-2027 Harvard MPII Mini-Peristaltic Pump

- Continuous low flow rates ideal for:
  - Slow perfusion studies
  - Controlled animal feeding
- Pump can take one or two tubes simultaneously, 1/16 in. ID
- Control knob for pumping speed
- Toggle switches for direction and x1 or x2 speed range selection
- Low electrical and mechanical noise
- Small size

The Harvard MPII Mini-Peristaltic Pump takes only one size of tubing, 1.6 mm ID x 3.2 mm OD (1/16 x 1/8 in). It can be used with either a single tube or two tubes simultaneously.

Two front panel controls provide flow rates from approximately 0.8 to 12.25 ml/min. The control knob provides variable adjustment from 0 to 100% of the selected flow rate range. The second control is a two position toggle switch marked x1, x2 which selects low or high flow rates, see table to right.

The easy-loading four-roller pump head is on top of the stout metal box. The back of the pump head effortlessly rotates into an 'open' position and either one or two tubes can be dropped into slots. The loaded section simply rotates back against spring loaded jaws and locks into place. The tubing is automatically in proper wiping contact with the pump head rollers. Each Pump is provided with a 12.5 mm (0.5 in) rod clamp on the back so that multiple pumps can be mounted vertically on a lattice rod.

MPII Flow Rates in ml/min

Switch Setting	With One Tube Min.	With One Tube Max.	With Two Tubes Min.	With Two Tubes Max.
x1	0.8 ml/min	7.00 ml/min	1.6 ml/min	14.00 ml/min
x2	1.5 ml/min	12.25 ml/min	3.0 ml/min	24.50 ml/min

Specifications

Output Pressure	In excess of 20 p.s.i.
Power	12 VDC 800 mA, 2.5 mm Connector, 115/230 VAC, 50/60 Hz, Universal power supply, 10 W
Dimensions, H x W x D	189 x 114 x 105 cm (3.5 x 4.5 x 4 in)
Weight	0.96 kg (2.1 lb)
Tubing ID	1/16 in

Catalog No.	$	Product
BS4 70-2027		MPII, 115/230 VAC, 50/60 Hz
BS4 55-4148		Pump Head Tubing Pieces. These silicone pump head tubing pieces have connectors on each end for 1/16 in ID tubing, pkg. of 10

Model 720 Compact Peristaltic Pumps

Model 720 Compact Peristaltic Pump

- Continuous infusion
- Battery back- up (30 hrs)
- Compact pump
- Minimal electromagnetic radiation
- Choose from low, mid, or high flow

The Model 720 Compact Peristaltic pump is a stand-alone pump series with flow rates of 0.02 to 15 ml/hr (Low Flow), 0.2 to 180 ml/hr (Mid-Flow) and 2 to 1800 ml/hr (High Flow). It is an ideal pump for applications which require limited size or weight, low EMI interference, the versatility of single and dual tubes sets (see table below) and/or external analog control.

An internal 9V lithium battery (supplied) will run the pump for up to 30 hours, protecting your experiments in the event of a power failure. Due to its power requirements, the high flow version is not available with battery backup.

The pump is typically powered by a 1.25 V internal reference voltage. An external reference voltage can be used to regulate flow rate and direction (pump direction can only be reversed by analog control). Under external control the speed dials serve as voltage attenuators to limit the external voltage to ±1.25 volts.

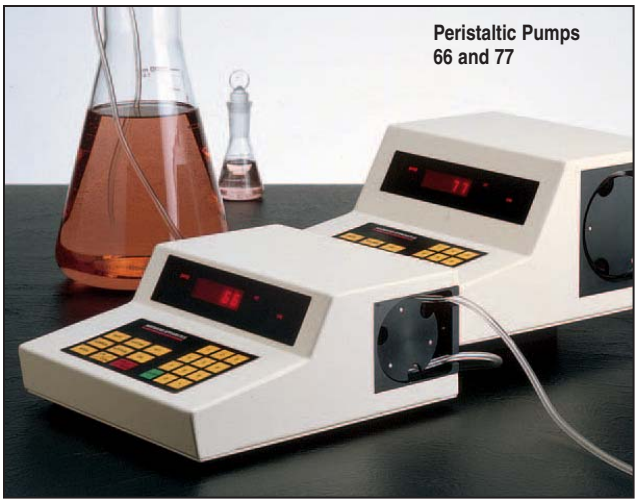
Supplied complete with 9 V lithium battery, wall-mounted AC adapter, and one of each of the general purpose silicone laboratory tubes (BS4 61-0243 and BS4 61-0244). Other tube sets are available, please see our website or contact customer service. For use with saline and most drugs, use silicone tubing. For use with solutions containing fats, such as IV diets, use C-FLEX® tubing. For use with petroleum-based fluids, use VITON® tubing.

Specifications

Repeatability	±3%		
Flow Control Range	20:1		
Power Source	Wall-mounted 9 VDC adapter		
Dimensions, H x W x D	6.4 x 5.7 x 10.2 cm (2.5 x 2.25 x 4 in)		
Weight	375 g (1 lb)		
Flow Rate:	High	Mid	Low
Min. (0.015 in. tube)	2 ml/hr	0.2 ml/hr	0.02 ml/hr
Max. (0.093 in. tube)	1800 ml/hr	180 ml/hr	15 ml/hr
120 VAC $	BS4 72-0001	BS4 61-0098	BS4 72-0002
220 VAC $	BS4 72-0008	BS4 61-0239	

Catalog No.	$	Product
BS4 61-0241		Silicone Tubing Set, 1-Ch, Female Luer to 22 ga, pkg. of 5
BS4 61-0242		Silicone Tubing Set, 1-Ch, Female Luer to 20 ga, pkg. of 5
BS4 61-0243		Silicone Tubing Set, 1-Ch, 0.062" ID Barbs, 0.8ml/hr pkg. of 5
BS4 61-0244		Silicone Tubing Set, 1-Ch, 0.062" ID Barbs, 5ml/hr pkg. of 5
BS4 61-0245		Silicone Tubing Set, 2-Ch, 0.062" ID Barbs, 3ml/hr pkg. of 5

Harvard Appartus Peristaltic Pump 66 & 77



- Highly accurate peristaltic pumps ±1%
- Unique ramped deceleration and 'slurp back'
- Continuous volume or batch mode operation
- Easy to use

Harvard Apparatus' 66 and 77 Peristaltic Pumps provide highly accurate and repeatable flow rates and are extremely easy to use.

High Accuracy

These pumps have the same high quality micro-stepping motor that creates the legendary accuracy of Harvard Apparatus' Syringe Pumps. Other peristaltic pumps have less accurate DC motors. No other peristaltic pump offers this quality of basic motor control. Additional accuracy features include ramped deceleration as the end-point is approached and a 'slurping' feature to prevent end of dispense dripping. As the end-point approaches, the pump slows to drop-by-drop delivery. As the last drop required is delivered, the pump immediately reverses one step and slurps back preventing unintended fluid delivery. Only these Harvard Apparatus innovations enable accuracy approaching that of a syringe pump from a peristaltic pump.

Fast and Easy

Routine work is made fast, easy and convenient with the 66 and 77 peristaltic pumps. Just enter the calibration factor of the tubing and the flow rate desired. The pump takes care of the rest. All settings are stored in non-volatile memory.

Flexibility

The 66 and 77 peristaltic pumps offer three pumping protocols for outstanding flexibility:

- Continuous flow – set the flow rate desired and the pump will run continuously until you stop it.
- Volume Mode – enter the volume to be delivered and the pump will run until that volume is delivered.
- Batch Mode – simply enter the time interval between dispenses and the number of dispenses you want and the pump will take it from there. It couldn't be more simple.

Two Sizes Available

Harvard Apparatus' peristaltic pump is offered in two sizes. The only difference between the two pumps is the flow rates provided. The 66 accepts smaller diameter tubing and provides flow rates from 0.01 to 210 ml/minute. The larger size 77 pump accepts larger diameter tubing to provide flow rates from 0.01 to 750 ml/minute.

Calibration by Volume or Weight

For precise volumetric calibration, measure the actual volume pumped compared to what the pump thinks it has delivered. Enter the exact amount actually delivered into the pump and the pump will automatically recalibrate itself in microliters per pump head revolution. For precise gravimetric calibration, connect the pump to a Mettler, Ohaus or Sartorius scale with a feedback connector. The pump now operates by weight and will recalibrate itself in grams per pump head revolution.

RS-232C Interface and TTL Input/Output

This pump can be controlled remotely by any personal computer via an RS-232C interface. Up to 99 pumps can be daisy-chained using the daisy-chain connector and cables offered as accessories. A connector for TTL input/output permits remote control of all functions.

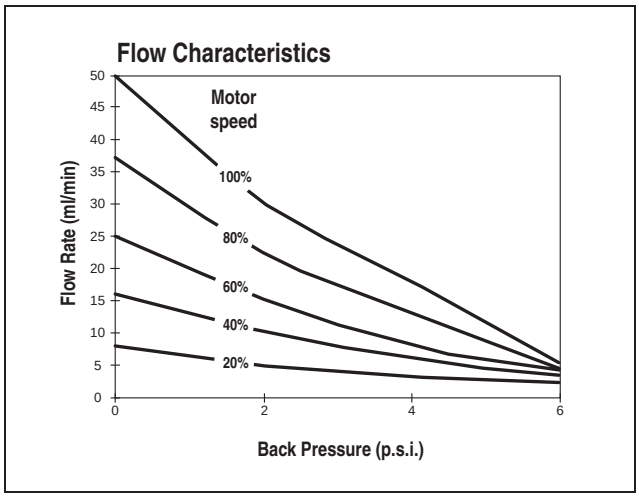
Specifications

Type	3 roller rotary peristaltic	
Accuracy	±1%	
Reproducibility	±1%	
RS-232C Interface	Chained dual bi-directional ports	
TTL Connector	9-pin connector	
Display	5 digits and 10 LED indicators	
Selectable Baud Rates	300, 600, 1200, 2400	
Step Rate:		
Minimum	27.3 sec/step	
Maximum	416.7 µsec/step	
Back Pressure	30 p.s.i. maximum	
Power	115/230 VAC, 50/60 Hz	
Voltage Range	95/130 VAC; 220/260 VAC	
Pump:	**Small 66 Pump**	**Large 77 Pump**
Tubing ID (R-1000 Only)*	1.5 and 3.2 mm (0.0625 and 0.125 in)	3.2 and 6 mm (0.125 and 0.25 in)
Flow Rates	0.01 to 210 ml/min	0.01 to 750 ml/min
Dimensions, H x W x D	22.9 x 20.6 x 8.9 cm (9 x 8.125 x 3.5 in)	24.1 x 20.6 x 12.7 cm (9.5 x 8.125 x 5 in)
Weight	3.53 kg (7.85 lb)	5.1 kg (11.25 lb)

Catalog No.	$	Product
BS4 55-7766		Peristaltic Pump 66
BS4 55-7777		Peristaltic Pump 77
BS4 55-4145		Daisy-Chain Connector; Computer to Pump
BS4 72-2478		Daisy-Chain Cable; Pump to Pump, 1.8 m (6 ft)
BS4 55-4144		Foot Switch
BS4 55-7757		Feedback Loop Connector for Mettler Scale
BS4 55-7758		Feedback Loop Connector for Ohaus Scale
BS4 55-7759		Feedback Loop Connector for Sartorius Scale

For Tygon® (R-1000) Ultra Soft Tubing, see page A81.

Harvard Apparatus/Instech Shuttle Pump



- Battery powered
- Perfect for cell culture work
- Fits in palm of your hand
- Flow rates up to 50 ml/minute
- Extremely energy efficient
- Gentle pulsatile flow
- Extended tubing life

This Shuttle Pump is based on a patented dual-channel shuttle pump mechanism that can deliver flow rates up to 50 ml/min, but is small and incredibly power efficient. This unique pump was designed for cell culture experiments conducted on the Space Shuttle, where weight and power consumption are significant constraints.

Efficient Design

This fluid pump uses two easily removable pumping chambers on either side of an oscillating shuttle. The balanced tube arrangement, high-efficiency motor, and 4 passive check valves result in a pump that is far more efficient than a typical peristaltic pump: 13 times higher flow rates with 60% lower weight and 90% lower power consumption.

Gentle Pumping Action

The oscillating shuttle does not squeeze the tubes to occlusion, making this device ideal for pumping cell suspensions and blood. Fluid can free flow through the pump in the forward direction, simplifying filling and purging, but limiting applications to those where outflow pressure is greater than inflow pressure. Single or dual channel operation. Join the two tubes to form a single input and output and thereby generate twice the flow rate with less pulsation.

Built-In Control Circuitry

Adjust the motor speed over a 20:1 range using the knob on the top of the pump.

OEM

The pump mechanism is also available for OEM applications. Please call Harvard Apparatus for details

Specifications

Flow Rate:	
Both Tubes Combined	2.5 to 50 ml/min (no back pressure)
Single Tube	1.25 to 25 ml/min (no back pressure)
Flow Waveform	Pulsatile
Pumping Chambers	2 per pump
Pulses per Minute	~45 at 6 ml/min (single channel)
Developed Pressure	9 p.s.i. (flow = 0), maximum
Tubing Life	> 3 months
Outlet Tubing (OD)	3.4 mm (0.135 in)
Power Source Provided	9 V battery and AC adapter
Battery Life	50 hrs under continuous operation, 9 V lithium
Dimensions, H x W x D	3.3 x 11.4 x 7.2 cm (1.3 x 4.5 x 2.8 in)

Catalog No.	$	Product
BS4 72-0011		Harvard Apparatus Shuttle Pump, 220 VAC
BS4 72-0012		Replacement 120 VAC Wall Adapter
BS4 72-0013		Replacement 220 VAC Wall Adapter
BS4 61-0271		Replacement Check Valve and Tubing Set for Shuttle Pump, pkg. of 4

Did you know ?

Harvard Apparatus now owns Biochrom (formerly Pharmacia Biotech (Biochrom) Ltd.). We manufacture an excellent range of high quality spectrophotometers. See the Molecular Biology Section N for complete details.

Ecoline Microprocessor Controlled Tubing Pumps, VC-280, VC-380, VC-360 and VC-Easy-Load

BS4 72-6426

VC-280 and VC-380

These two pumps feature exchangeable rotors with either 2 or 3 rollers providing lower pulsation, higher flow rates or elevated differential pressures. These pumps are supplied with the rotor that accepts 1.6 mm ID tubing. One pump is supplied with the 2 roller rotor and the other is supplied with the 3 rotor roller. They both have a safety cutout feature that stops the rotation of the rotor when the rotor cover is opened. Using standard tubing they provide flow rate ranges from 1.6 to 5,000 ml/minute with a differential pressure of 1.5 bar (22 PSI)*.

VC-360

This pump features 3 convex rollers providing lower pulsations than the other two pumps. Its rotor is not interchangeable with other rotors. It has a hinged tube-bed with wide opening angle allowing rapid tube change over. It uses standard pump tubing and provides a flow rate range from 0.25 to 1,300 ml/minute with a differential pressure of 1.5 bar (22 PSI)*.

VC-Easy-Load

This pump features 3 rollers and an easily accessible pump-head that allows rapid tube change-over. It has a Polysulfone pump-head housing and uses standard pump tubing. This pump provides a flow rate range from 0.23 to 1,600 ml/min with a differential pressure of 1.5 bar (22 PSI)*.

**Note: This is the possible differential pressure using appropriate tubing material; tubing with smaller inner diameters may enable higher pressure.*

These pumps use Standard Pump Tubing, see page A63.

Applications

- Ideal as a re-circulating pump for coolant thermostat baths
- Externally controlled spectrophotometer cuvette filling

Features/Benefits

- Economical and Powerful
- Stackable Pumps for Dosing and Filling Applications Requiring Variable Flow Rates
- Robust Stainless Steel Housing
- Convex Rollers Treat the Liquid and Tubing Gently
- Reproducible Fluid Transfer in Laboratories and Industry
- Accurate and Reproducible Speed-Setting
- Analog Interface
- Suitable Pump for SCP Controller, Part of the Universal Servo Control Perfusion System

Specifications

Flow Rates:	
VC-280	1.7 to 5400 ml/min per channel
VC-380	1.6 to 5000 ml/min per channel
VC-360	0.25 to 1300 ml/min per channel
Channels	1
Speed	3.5 to 350 rpm
Speed Setting/Control	1 to 99%, resolution 1%, 2-digit potentiometer
Motor Type	DC motor
Power Consumption	100 W
Mains Connection	115 VAC, 60 Hz or 230 VAC, 50 Hz, adjustable
Protection Rating	IP 30
Remote Control	Analog interface

Economical Microprocessor Controlled Tubing Pumps

Catalog No.	$	Product	# Rollers	Flow Rate Range ml/min	Dimensions, H x W x D	Weight, kg	Voltage
BS4 72-6426		Ecoline, VC-280	2	1.7 to 5400	138 x 169 x 256 mm	5.2	230 VAC
BS4 72-6427		Ecoline, VC-280	2	1.7 to 5400	138 x 169 x 256mm	5.2	115 VAC
BS4 72-6428		Ecoline, VC-380	3	1.6 to 5000	138 x 169 x 256 mm	5.3	230 VAC
BS4 72-6429		Ecoline, VC-380	3	1.6 to 5000	138 x 169 x 256 mm	5.3	115 VAC
BS4 72-6430		Ecoline, VC-360	3	0.25 to 1300	138 x 169 x 238 mm	4.8	230 VAC
BS4 72-6431		Ecoline, VC-360	3	0.25 to 1300	138 x 169 x 238 mm	4.8	115 VAC
BS4 72-6436		Ecoline, VC-Easy-Load	3	0.23 to 1600	138 x 169 x 285 mm	5.2	230 VAC
BS4 72-6437		Ecoline, VC-Easy-Load	3	0.23 to 1600	138 x 169 x 285 mm	5.2	115 VAC
BS4 72-6439		Repl. Rotor for VC-280	2	-	-	-	-
BS4 72-6440		Repl. Rotor for VC-380	3	-	-	-	-
BS4 72-6438		Drive for VC-Easy-Load	-	-	-	-	-

Standard Tygon® R-3603/R-3607 Tubing, 15 m roll

				Minimum and Maximum Flow Rates with Pump (ml/min)							
		ID	WT	VC-280		VC-380		VC-360		VC-Easy-Load	
Catalog No.	$	mm	mm	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
BS4 73-1806		0.8	1.6	-	-	-	-	0.25	25	0.23	23
BS4 73-1807		1.6	1.6	1.7	170	1.6	160	0.9	90	0.86	86
BS4 73-1808		3.2	1.6	6.6	660	5.9	590	3.5	350	3.2	320
BS4 73-1809		4.8	1.6	15	1500	13	1300	7.7	770	6.5	650
BS4 73-1810		6.4	1.6	25	2500	23	2300	13	1300	11	1060
BS4 73-1811		8	1.6	37	3700	34	3400	-	-	16	1600
BS4 73-1814		9.5	1.6	48	4800	44	4400	-	-	-	-
BS4 73-1815		11.1	1.6	54	5400	50	5000	-	-	-	-
BS4 73-1812		4.8	2.4	13	1300	12	1200	-	-	-	-
BS4 73-1813		6.4	2.4	23	2300	20	2000	-	-	-	-
BS4 73-3249		8	2.4	35	3500	31	3100	-	-	-	-
BS4 73-3250		9.5	2.4	46	4600	42	4200	-	-	-	-

REGLO Digital Programmable Peristaltic Pump

BS4 73-3296

- Dispensing Mode Flow Rates from 0.002 to 68 ml/min
- Snap-on MS/CA Click 'n' Go Cassettes, see page A60
- RS-232 interface
- Adjust and calibrate dispensing volumes in ml and flow rates in ml/min for accurate and reproducible results
- Easy to use with pre-programmed flow-rates for all available tube sizes
- Dispensing by volume, time or intervals for each unique application
- Overload protection and indicator automatically stops pump to prevent damage
- Display readout: speed in 1%-steps and flow rate in ml/min
- Motor and ventilation permit 24 hour continuous operation
- Ease of use and a clear function display are the special features of these small pumps. They offer versatile dispensing functions and provide reproducible, accurate results and take up very little bench-space.

REGLO Digital 2 channels, 6, 8 or 12 pump rollers

Tube-bed with 2 snap-on Click 'n' Go Casssettes for 3-stop collared tubing.

REGLO Digital 4 channels, 6, 8 or 12 pump rollers

Tube-bed with 4 snap-on Click 'n' Go Casssettes for 3-stop collared tubing.

Catalog No.	$	Product
BS4 73-3054		MS/CA Click 'n' Go Cassette
BS4 73-3055		MS/CA Pressure Lever Cassette
BS4 73-3050		Foot Switch for REGLO Digital Pumps

Specifications	REGLO Digital 2 Channels			REGLO Digital 4 Channels		
	MS-2/6-160	MS-2/8-160	MS-2/12-160	MS-4/6-100	MS-4/8-100	MS-4/12-100
Channels	2	2	2	4	4	4
Pump Rollers	6	8	12	6	8	12
Flow Rates, Minimum	0.003 ml/min	0.002 ml/min	0.002 ml/min	0.002 ml/min	0.002 ml/min	0.001 ml/min
Flow Rates, Maximum	68 ml/min	57 ml/min	38 ml/min	43 ml/min.	35 ml/min	24 ml/min
Speed Range	1.6 to 160 rpm	1.6 to 160 rpm	1.6 to 160 rpm	1 to 100 rpm	1 to 100 rpm	1 to 100 rpm
Mains Connection	115 V / 50 Hz or 230 V /50 Hz					
Power Consumption	20 W					
Reversible Flow	yes					
Set Point	digital, 3–4 digits according to function (mode), LED display					
RS-232 Interface	for control of all functions					
Display Input (TTL Level)	Run/Stop, AutoStart					
Back Pressure, Max.	1.0 bar (14.5 PSI)					
Suction Height	7–8 m					
Protection Rating	IP 30					
Tubing Cassette	MS/CA Click 'n' Go - Cassettes are included					
Dimensions, H x W x D	135 x 100 x 178 mm (5.3 x 3.9 x 7 in)		135 x 100 x 190 mm (5.3 x 3.9 x 7.5 in)			
Weight	2.0 kg (4.4 lbs)			2.1 kg (4.6 lbs)		
Catalog No. (115 VAC)	BS4 73-2948	BS4 73-2949	BS4 73-3298	BS4 73-2950	BS4 73-2915	BS4 73-3296
$						
Catalog No. (230 VAC)	BS4 73-2444	BS4 73-2445	BS4 73-3299	BS4 73-2446	BS4 73-0100	BS4 73-3297
$						

REGLO Digital Programmable Peristaltic Pump

Flow Rates for REGLO Digital Pumps using 3-Stop Collared Tubing

		REGLO Digital 2 channels						REGLO Digital 4 channels					
	3-stop tubing	MS-2/6-160 ml/min per channel		MS-2/8-160 ml/min per channel		MS-2/12-160 ml/min per channel		MS-4/6-100 ml/min per channel		MS-4/8-100 ml/min per channel		MS-4/12-100 ml/min per channel	
AME#	ID mm	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
00	0.13	0.003	0.22	0.002	0.17	0.002	0.15	0.002	0.14	0.002	0.11	0.001	0.093
01	0.19	0.005	0.45	0.004	0.37	0.004	0.34	0.003	0.28	0.003	0.23	0.003	0.21
02	0.25	0.008	0.76	0.007	0.65	0.007	0.61	0.005	0.48	0.005	0.41	0.004	0.38
03	0.38	0.017	1.7	0.015	1.5	0.014	1.4	0.011	1.1	0.01	0.94	0.009	0.88
04	0.44	0.023	2.3	0.020	2.0	0.019	1.9	0.014	1.4	0.013	1.3	0.012	1.2
05	0.51	0.031	3.1	0.027	2.7	0.025	2.5	0.019	1.9	0.017	1.7	0.016	1.6
06	0.57	0.038	3.8	0.033	3.3	0.031	3.1	0.024	2.4	0.021	2.1	0.019	1.9
07	0.64	0.048	4.8	0.042	4.2	0.039	3.9	0.03	3	0.026	2.6	0.024	2.4
08	0.76	0.067	6.7	0.058	5.8	0.053	5.3	0.042	4.2	0.036	3.6	0.033	3.3
09	0.89	0.090	9.0	0.079	7.9	0.071	7.1	0.057	5.7	0.049	4.9	0.044	4.4
10	0.95	0.10	10	0.089	8.9	0.079	7.9	0.064	6.4	0.056	5.6	0.05	5
11	1.02	0.12	12	0.10	10	0.090	9.0	0.073	7.3	0.063	6.3	0.056	5.6
12	1.09	0.13	13	0.11	11	0.10	10	0.083	8.3	0.072	7.2	0.063	6.3
13	1.14	0.14	14	0.12	12	0.11	11	0.09	9	0.078	7.8	0.067	6.7
14	1.22	0.16	16	0.14	14	0.12	12	0.1	10	0.088	8.8	0.075	7.5
15	1.3	0.18	18	0.16	16	0.13	13	0.11	11	0.1	10	0.083	8.3
16	1.42	0.21	21	0.18	18	0.15	15	0.13	13	0.11	11	0.094	9.4
17	1.52	0.24	24	0.20	20	0.17	17	0.15	15	0.13	13	0.1	10
18	1.65	0.28	28	0.23	23	0.19	19	0.17	17	0.15	15	0.12	12
19	1.75	0.31	31	0.26	26	0.20	20	0.19	19	0.16	16	0.13	13
20	1.85	0.34	34	0.28	28	0.21	21	0.21	21	0.17	17	0.13	13
21	2.06	0.40	40	0.33	33	0.24	24	0.25	25	0.2	20	0.15	15
22	2.29	0.46	46	0.38	38	0.27	27	0.29	29	0.24	24	0.17	17
23	2.54	0.53	53	0.44	44	0.31	31	0.33	33	0.27	27	0.19	19
24	2.79	0.59	59	0.50	50	0.34	34	0.37	37	0.31	31	0.21	21
25	3.17	0.68	68	0.57	57	0.38	38	0.43	43	0.35	35	0.24	24

These pumps use 3-Stop Collared Tubing, see page A61, and MS/CA Click 'n' Go Cassettes, see page A60.

REGLO Analog Peristaltic Pump with Variable Speed Drive

BS4 73-2951

- Start/Stop, Speed and Direction Functions
- Flow Rates from 0.003 to 58 ml/min
- Uses snap-on MS/CS Click 'n' Go Cassettes, see page A60
- Uses 3-Stop Collared Tubing, see page A61
- Analog Interface
- 2 Digit Potentiometer and Overload Indicators
- 2 or 4 Channels Available
- In addition to the overload indicator and the analog interface the Reglo Analog is now suitable for continuous operation!
- Suitable Pump for SCP Controller, Part of the Universal Servo Control Perfusion System

Catalog No.	$	Product
BS4 73-3054		MS/CA Click 'n' Go Cassette
BS4 73-3055		MS/CA Pressure Lever Cassette
BS4 73-3049		Foot Switch for REGLO Analog Pumps

REGLO Analog 2 Channels, 6, 8, or 12 pump rollers

Roller head with 2 snap-on MS/CA Click 'n' Go Cassettes for 3-stop collared tubing.

REGLO Analog 4 channels, 6, 8, or 12 pump rollers

Roller head with 4 snap-on MS/CA Click 'n' Go Cassettes for 3-stop collared tubing.

Specifications	REGLO Analog 2 Channels			REGLO Analog 4 Channels		
	MS-2/6-160	MS-2/8-160	MS-2/12-160	MS-4/6-100	MS-4/8-100	MS-4/12-100
Channels	2	2	2	4	4	4
Pump Rollers	6	8	12	6	8	12
Flow Rates, Minimum	0.002 ml/min	0.002 ml/min	0.002 ml/min	0.002 ml/min	0.002 ml/min	0.001 ml/min
Flow Rates, Maximum	68 ml/min	57 ml/min	38 ml/min	43 ml/min.	35 ml/min	24 ml/min
Speed Range	1.6 to 160 rpm	1.6 to 160 rpm	1.6 to 160 rpm	1 to 100 rpm	1 to 100 rpm	1 to 100 rpm
Mains Connection	115 V / 50 Hz or 230 V /50 Hz					
Power Consumption	20W					
Reversible Flow	yes					
Speed Setting	3 to 99%, resolution 1%, 2 digit potentiometer					
Analog Interface Input	Speed control 0–5 V or 0–10 V and 0–20 mA or 4–20 mA respectively					
Digital Input (TTL Level)	Rotation direction, Start/Stop					
Speed Control	Adjustable in 1% steps (0–99 %)					
Back Pressure, Max.	1.0 bar (14.5 PSI)					
Suction Height	7–8 m					
Protection Rating	IP 30					
Tubing Cassette	MS/CA Click 'n' Go - Cassettes are included					
Dimensions, H x W x D	143 x 100 x 178 mm (5.6 x 3.9 x 7 in)			143 x 100 x 190 mm (5.6 x 3.9 x 7.6 in)		
Weight	2.0 kg (4.4 lbs)			2.1 kg (4.6 lbs)		
Catalog No. (115 VAC)	BS4 73-2951	BS4 73-2952	BS4 73-3294	BS4 73-2953	BS4 73-0113	BS4 73-3292
$						
Catalog No. (230 VAC)	BS4 73-2447	BS4 73-2448	BS4 73-3295	BS4 73-2449	BS4 73-0114	BS4 73-3293
$						

REGLO Analog Peristaltic Pump with Variable Speed Drive

Flow Rates for REGLO Analog Pumps using 3-Stop Collared Tubing

		REGLO Analog 2 channels						REGLO Analog 4 channels					
	3-stop tubing	MS-2/6-160 ml/min per channel		MS-2/8-160 ml/min per channel		MS-2/12-160 ml/min per channel		MS-4/6-100 ml/min per channel		MS-4/8-100 ml/min per channel		MS-4/12-100 ml/min per channel	
AME#	ID mm	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
00	0.13	0.005	0.22	0.004	0.17	0.003	0.15	0.003	0.14	0.003	0.11	0.002	0.093
01	0.19	0.009	0.45	0.008	0.37	0.007	0.34	0.006	0.28	0.005	0.23	0.005	0.21
02	0.25	0.015	0.76	0.013	0.65	0.012	0.61	0.01	0.48	0.009	0.41	0.008	0.38
03	0.38	0.035	1.7	0.030	1.5	0.028	1.4	0.022	1.1	0.019	0.94	0.018	0.88
04	0.44	0.046	2.3	0.040	2.0	0.038	1.9	0.029	1.4	0.025	1.3	0.024	1.2
05	0.51	0.061	3.1	0.054	2.7	0.050	2.5	0.038	1.9	0.034	1.7	0.031	1.6
06	0.57	0.076	3.8	0.067	3.3	0.062	3.1	0.048	2.4	0.042	2.1	0.039	1.9
07	0.64	0.096	4.8	0.084	4.2	0.077	3.9	0.06	3	0.052	2.6	0.048	2.4
08	0.76	0.13	6.7	0.12	5.8	0.11	5.3	0.084	4.2	0.073	3.6	0.067	3.3
09	0.89	0.18	9.0	0.16	7.9	0.14	7.1	0.11	5.7	0.098	4.9	0.088	4.4
10	0.95	0.20	10	0.18	8.9	0.16	7.9	0.13	6.4	0.11	5.6	0.099	5
11	1.02	0.23	12	0.20	10	0.18	9.0	0.15	7.3	0.13	6.3	0.11	5.6
12	1.09	0.27	13	0.23	11	0.20	10	0.17	8.3	0.14	7.2	0.13	6.3
13	1.14	0.29	14	0.25	12	0.22	11	0.18	9	0.16	7.8	0.13	6.7
14	1.22	0.33	16	0.28	14	0.24	12	0.2	10	0.18	8.8	0.15	7.5
15	1.30	0.37	18	0.31	16	0.26	13	0.23	11	0.2	10	0.17	8.3
16	1.42	0.43	21	0.37	18	0.30	15	0.27	13	0.23	11	0.19	9.4
17	1.52	0.48	24	0.41	20	0.33	17	0.3	15	0.26	13	0.21	10
18	1.65	0.56	28	0.47	23	0.37	19	0.35	17	0.29	15	0.23	12
19	1.75	0.61	31	0.51	26	0.40	20	0.38	19	0.32	16	0.25	13
20	1.85	0.67	34	0.56	28	0.43	21	0.42	21	0.35	17	0.27	13
21	2.06	0.79	40	0.66	33	0.49	24	0.5	25	0.41	20	0.3	15
22	2.29	0.92	46	0.76	38	0.55	27	0.58	29	0.48	24	0.34	17
23	2.54	1.1	53	0.88	44	0.62	31	0.66	33	0.55	27	0.39	19
24	2.79	1.2	59	0.99	50	0.69	34	0.74	37	0.62	31	0.43	21
25	3.17	1.4	68	1.1	57	0.75	38	0.85	43	0.71	35	0.47	24

These pumps use 3-Stop Collared Tubing, see page A61, and MS/CA Click 'n' Go Cassettes, see page A60.

Microprocessor Controlled Pumps With or Without Dispensing

BS4 73-3132

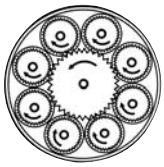


Figure A

These tubing pumps are ideal for a wide variety of applications including perfusion of animal tissue slices and in-vitro toxicological procedures. They are available in a variety of channel configurations and have two flow rate ranges. Each pump is also available in two models. Select from a pump with or without a dispensing function.

These pumps feature a unique planetary drive system where the sun wheel drives each roller directly (see Figure A). This prevents axial push-pull friction on the tubing which results in increased service-life of the tubing, lower pulsation and high repeatability.

Flow Rates for Microprocessor Controlled Pumps With or Without Dispensing

2-Stop Tubing		IP and IPC Pumps Flow Rates ml/min per channel		IP-N and IPC-N Pumps Flow Rates ml/min per channel	
ENE#	ID mm	min.	max.	min.	max.
00	0.13	0.002	0.15	0.0004	0.039
01	0.19	0.003	0.26	0.0007	0.066
02	0.25	0.005	0.41	0.001	0.10
03	0.38	0.009	0.86	0.003	0.22
04	0.44	0.011	1.1	0.003	0.28
05	0.51	0.015	1.5	0.004	0.38
06	0.57	0.019	1.9	0.005	0.46
07	0.64	0.023	2.3	0.006	0.58
08	0.76	0.032	3.2	0.009	0.81
09	0.89	0.044	4.4	0.011	1.1
10	0.95	0.049	4.9	0.012	1.2
11	1.02	0.057	5.7	0.014	1.4
12	1.09	0.064	6.4	0.016	1.6
13	1.14	0.070	7.0	0.017	1.7
14	1.22	0.079	7.9	0.020	2.0
15	1.30	0.089	8.9	0.022	2.2
16	1.42	0.11	11	0.026	2.6
17	1.52	0.12	12	0.030	3.0
18	1.65	0.14	14	0.035	3.5
19	1.75	0.15	15	0.039	3.9
20	1.85	0.17	17	0.043	4.3
21	2.06	0.21	21	0.052	5.2
22	2.29	0.25	25	0.062	6.2
23	2.54	0.30	30	0.075	7.5
24	2.79	0.35	35	0.088	8.8
25	3.17	0.44	44	0.11	11

Applications

- Ideal for Perfusion of Animal Tissue Slices
- Toxicological In-Vitro Use
- Flow Injection Analyzers

Features/Benefits

- Extremely Low Pulsation
- Highest Accuracy
- Very High Repeatability on all Channels
- Lacquered Stainless Steel Housing for Long Life
- Available with 4, 8, 12, 16 or 24 Channels
- 2 Flow Rate Ranges Available
- Available with our without Dispensing Functions
- 8 Actively Driven Stainless Steel Rollers
- Microprocessor Controlled Drive
- Ideal for Low-Flow, Multi-Channel Fluid Transfer and Dosing or Filling Applications
- Flow Rate and Dispensing Volume (Dispensing Models Only) can be Calibrated
- CA Click 'n' Go Cassettes Provide Defined and Repeatable Occlusion Conditions, see page A60
- Cassettes are included
- Remote Controllable Via PC (RS-232) – dispensing models only

Specifications

Operating Modes:	
IPC With Dispensing	11 operating modes and calibrating functions
IP Without Dispensing	Run/Stop, Speed Control and Direction only, no dispensing features or calibrating functions
Flow Rates	0.0004 to 11 ml/min or 0.002 to 44 ml/min (per channel)
Channels	4, 8, 12, 16 or 24
Rollers	8
Operating Panel:	6-button membrane key-pad with LED display
IPC With Dispensing	Various operating modes for dosing applications
IP Without Dispensing	2 LEDs indicating LOCAL or REMOTE operation
Speed Setting:	
IPC With Dispensing	In %, resolution 0.1% (rpm) or in µl/min or ml/min (flow rate)
IP Without Dispensing	In rpm, resolution 0.1 rpm or 0.03 rpm (IP-N) or in %, resolution 0.1% (rpm)
Speed Control	Closed loop control for load independent speed
Remote Control:	
IPC With Dispensing	RS-232 "in" and "out" - Digital inputs (TTL level) - Analog input for speed control - Analog output for speed monitoring
IP Without Dispensing	Analog interface (no RS-232)

Microprocessor Controlled Pumps With or Without Dispensing

Microprocessor Controlled Tubing Pumps								
Catalog No. IPC Pumps With Dispensing	$	Catalog No. IP Pumps Without Dispensing	$	# Channels	Flow Rate Range	Dimensions, H x W x D	Weight	Voltage
BS4 73-3129		BS4 73-3147		4	0.002 to 44 ml/min	130 x 175 x 180 mm	4.6 kg	230 VAC
BS4 73-3130		BS4 73-3148		4	0.002 to 44 ml/min	130 x 175 x 180 mm	4.6 kg	115 VAC
BS4 73-3131		BS4 73-3149		8	0.002 to 44 ml/min	130 x 175 x 220 mm	5.1 kg	230 VAC
BS4 73-3132		BS4 73-3150		8	0.002 to 44 ml/min	130 x 175 x 220 mm	5.1 kg	115 VAC
BS4 73-3133		BS4 73-3151		12	0.002 to 44 ml/min	130 x 175 x 260 mm	5.8 kg	230 VAC
BS4 73-3134		BS4 73-3152		12	0.002 to 44 ml/min	130 x 175 x 260 mm	5.8 kg	115 VAC
BS4 73-2450		BS4 73-3153		16	0.002 to 44 ml/min	130 x 175 x 300 mm	6.5 kg	230 VAC
BS4 73-3135		BS4 73-3154		16	0.002 to 44 ml/min	130 x 175 x 300 mm	6.5 kg	115 VAC
BS4 73-3136		BS4 73-3155		24	0.002 to 44 ml/min	130 x 175 x 380 mm	7.9 kg	230 VAC
BS4 73-3137		BS4 73-3156		24	0.002 to 44 ml/min	130 x 175 x 380 mm	7.9 kg	115 VAC
IPC-N Pumps		**IP-N Pumps**						
BS4 73-3138		BS4 73-3157		4	0.0004 to 11 ml/min	130 x 175 x 180 mm	4.6 kg	230 VAC
BS4 73-3139		BS4 73-3158		4	0.0004 to 11 ml/min	130 x 175 x 180 mm	4.6 kg	115 VAC
BS4 73-3140		BS4 73-3159		8	0.0004 to 11 ml/min	130 x 175 x 220 mm	5.1 kg	230 VAC
BS4 73-3141		BS4 73-3160		8	0.0004 to 11 ml/min	130 x 175 x 220 mm	5.1 kg	115 VAC
BS4 73-2421		BS4 73-3161		12	0.0004 to 11 ml/min	130 x 175 x 260 mm	5.8 kg	230 VAC
BS4 73-3142		BS4 73-3162		12	0.0004 to 11 ml/min	130 x 175 x 260 mm	5.8 kg	115 VAC
BS4 73-3143		BS4 73-3163		16	0.0004 to 11 ml/min	130 x 175 x 300 mm	6.5 kg	230 VAC
BS4 73-3144		BS4 73-3164		16	0.0004 to 11 ml/min	130 x 175 x 300 mm	6.5 kg	115 VAC
BS4 73-3145		BS4 73-3165		24	0.0004 to 11 ml/min	130 x 175 x 380 mm	7.9 kg	230 VAC
BS4 73-3146		BS4 73-3166		24	0.0004 to 11 ml/min	130 x 175 x 380 mm	7.9 kg	115 VAC

These pumps use 2-Stop Collared Pump Tubing, see page A62 and CA Click 'n' Go Cassettes, see page A60.

Ecoline 4-Channel and 8-Channel Microprocessor Controlled Tubing Pumps

BS4 72-6434

BS4 72-6432

The Ecoline 4 Channel and 8 Channel Tubing Pumps are economical, compact, multi-channel pumps with wider flow rate ranges than the IP/IPN, see page A51, and REGLO Analog/Digital pump lines, see pages A45 and A47, and an alternative to the MCP/BVP multi-channel pump configurations. They are ideal for complex pumping applications like recirculating organ perfusion systems. The wide flow range of flow rates possible makes them useful for organ perfusion applications from Mice to Rabbits. Multiple channels can also be coupled together with Y-adapters to increase single line flow rates.

These pumps feature the MS/CA Click 'n' Go Cassettes. These new, innovative tubing cassettes provide the following advantages:

- Automatic tubing pressure
- Pumping conditions that are defined and repeatable at a later date.
- Long term channel-to-channel conformity
- Calibrated, fatigue-free spring guarantees optimal, reproducible tubing pressure independent of diameter, material and state of tubing

Specifications

Flow Rate:	
Ecoline 4-Channel	0.003 to 83 ml/min per channel
Ecoline 8-Channel	0.005 to 150 ml/min per channel
Channels:	
Ecoline 4-Channel	4
Ecoline 8-Channel	8
Number of Rollers:	
Ecoline 4-Channel	12
Ecoline 8-Channel	6
Motor Type	DC motor
Speed Setting/Control	1 to 99%, resolution 1%, 2-digit potentiometer
Speed	3.5 to 350 rpm
Power Consumption	100 W
Mains Connection	115 VAC, 60 Hz or 230 VAC, 50 Hz, adjustable
Protection Rating	IP 30
Remote Control	Analog interface
Tubing Casettes	MS/CA Click 'n' Go Cassettes Cassettes are included
Dimensions, H x W x D:	
Ecoline 4-Channel	138 x 169 x 281 mm
Ecoline 8-Channel	138 x 169 x 313 mm
Weight:	
Ecoline 4-Channel	5.4 kg
Ecoline 8-Channel	5.5 kg

Catalog No.	$	Product
BS4 72-6434		Ecoline Roller Pump VC-MS/CA4-12, 4 Channels, 230 VAC
BS4 72-6435		Ecoline Roller Pump VC-MS/CA4-12, 4 Channels, 115 VAC
BS4 72-6432		Ecoline Roller Pump VC-MS/CA8-6, 8 Channels, 230 VAC
BS4 72-6433		Ecoline Roller Pump VC-MS/CA8-6, 8 Channels, 115 VAC
BS4 73-3054		MS/CA Cassette, Click 'n' Go, POM-C
BS4 73-3055		MS/CA Cassette, Pressure Lever, POM-C
BS4 73-3051		Foot Switch for Ecoline Pump
BS4 72-6438		Drive for VC-MS/CA4-12 and VC-MS/CA8-6 (without pump-head)

Applications

- Ideal for non-monitored long-term use
- Ideal for complex multi-channel pumping applications like recirculating organ/tissue bath systems

Features/Benefits

- Economical and Powerful
- Stackable Pumps for Dosing and Filling Applications Requiring Variable Flow Rates
- MS/CA Click 'n' Go Cassettes with Auto Pressure Setting, see page A60
- Uses 3-Stop Collared Tubing, see page A61
- Differential pressure 1.0 bar
- Analog Interface
- Robust Stainless Steel Housing
- Suitable Pump for SCP Controller, Part of the Universal Servo Control Perfusion System

Flow Rates for Ecoline VC-MS/CA8-6

AME#	3-Stop Tubing ID mm	Flow rates ml/min per channel min.	max.
00	0.13	0.005	0.49
01	0.19	0.010	0.98
02	0.25	0.017	1.7
03	0.38	0.038	3.8
04	0.44	0.050	5.0
05	0.51	0.067	6.7
06	0.57	0084	8.4
07	0.64	0.10	10
08	0.76	0.15	15
09	0.89	0.20	20
10	0.95	0.22	22
11	1.02	0.26	26
12	1.09	0.29	29
13	1.14	0.32	32
14	1.22	0.36	36
15	1.30	0.40	40
16	1.42	0.47	47
17	1.52	0.53	53
18	1.65	0.61	61
19	1.75	0.67	67
20	1.85	0.73	73
21	2.06	0.87	87
22	2.29	1.0	100
23	2.54	1.2	120
24	2.79	1.3	130
25	3.17	1.5	150

MCP Pump Drive

- Microprocessor controlled, digital drive stores 4 programs in memory
- Flow-rates of the pump-heads are pre-programmed according to the different standard tubing sizes
- Dispensing volumes in ml and flow rates in ml/min
- Calibrate in ml/min
- Various dispensing modes (time, volume, interval and flow rate, drip-free)
- MAX-key for priming and rapid filling or emptying of the tube system.

Dispense by speed (rpm), volume (ml), time (0.1 seconds to 999 hours), flow rate (ml/min) or interval
This programmable pump drive offers various dispensing modes, providing highly reproducible and accurate results.

A wide selection of pump heads with single or multi-channel capabilities are available for the MCP pump drive. Different pump heads can be found on pages A55 to A59.

Specifications

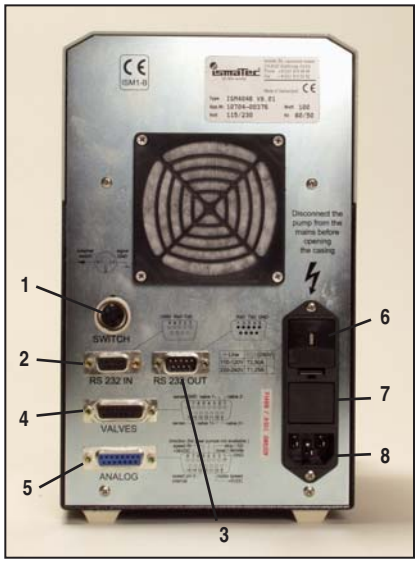
Model	MCP pump drive only, pump head must be purchased seperately
Speed	1 to 240 rpm with 0.1 rpm resolution
Back Pressure	1.5 bar maximum (22 PSI)
Mains Connection	115 V (50/60 Hz) or 230 V (50/60 Hz)
Power Consumption	100 W maximum
RS-232 Interface	Baud rate 9600 or 1200 baud, 8 bit, 1 stop bit, no parity for operation controlling via PC, additional RS-232 output for cascade control or up to 8 pumps
Analog Interface	Speed control 0–5 V or 0–10 V respectively 0–20 mA or 4–20 mA
Digital Input (TTL Level)	Flow direction, start/stop, speed control
Valve Plug	1 for 24 V valve
Protection Rating	IP 30
Electro Magnetic Immunity	EN 50082-1
Electro Magnetic Radiation	EN 55022 Class B
Operating Conditions	0˚ to 40˚C (normal environmental conditions)
Dimensions, H x W x D	260 x 155 x 220 mm (10.2 x 6.1 x 8.7 in) without pump head
Weight	6.4 kg (14.1 lbs)

Catalog No.	$	Product
BS4 73-3026		MCP Pump Drive, 230 VAC
BS4 73-3029		MCP Pump Drive, 115 VAC
BS4 73-3048		Foot Switch for MCP Pump Drive

Multi-functional display
For tube sizes, speed, flow-rates, dispensing time, dispensing volume, interval duration and totally delivered volume as well as operational mode, flow direction and MAX-key for priming.

Calibratable: Dispensing volume/Flow-rate
Volume and flow-rate can be pre-set and calibrated in ml or ml/min. The drives are pre-calibrated according to the pre-programmed pump-heads and tube sizes.

Application:
Filling of bottles and test tubes as well as dispensing of pre-defined volumes.



Rear panel of MCP

1. Foot Switch/Hand Dispenser
2. RS-232 Interface (in)
3. RS-232 Interface (out)
4. Valve Connector
5. Analog Interface
6. Voltage Selector
7. Fuse Holder
8. Mains Supply Socket

All functions of the MCP drive can be controlled via PC via the RS-232 interface.

BVP Pump Drive

- Smooth operation at a low noise level
- Double overload protection
- Robust drive for long-term operations
- Energy saving due to low power consumption
- Small footprint, 2 drives are stackable
- Various interchangeable pump-heads
- 3 digit potentiometer speed selector, adjustable in 0.1%-steps, 1 to 99%
- MAX-Switch (e.g. for priming of the tubing system)
- Switchable flow direction for clockwise and counter-clockwise operation
- Suitable Pump for SCP Controller, Part of the Universal Servo Control Perfusion System

The BVP pump drive is very robust and designed for continuous operation

The BVP drive can be combined with a wide selection of pump-heads. It is equipped with a 3 digit potentiometer speed selector and an analog interface.

Specifications	
Model	BVP pump drive only, pump head must be purchased serparately
Speed	2 to 240 rpm, adjustable in 0.1 % steps
Back Pressure	1.5 bar maximum (22 PSI)
Mains Connection	115 V (50/60 Hz) or 230 V (50/60 Hz)
Power Consumption	100 W maximum
Analog Interface	Speed control 0–5 V or 0–10 V respectively 0–20 mA or 4–20 mA
Digital Input (TTL Level)	Flow direction, start/stop
Protection Rating	IP 30
Electro Magnetic Immunity	EN 50082-1
Electro Magnetic Radiation	EN 55022, Class B
Operating Conditions	0˚ to 40 ˚C (normal environmental conditions)
Dimensions, H x W x D	260 x 155 x 220 mm (9.8 x 6.1 x 8.7 in) without pump-head
Weight	5.7 kg (12.6 lbs)

Catalog No.	$	Product
BS4 73-3028		BVP Pump Drive, 230 VAC
BS4 73-3027		BVP Pump Drive, 115 VAC
BS4 73-3049		Foot Switch for BVP Pump Drive

A wide selection of pump heads with single or multi-channel capabilities are available for the BVP pump drive. Pump heads can be rapidly interchanged so that a single pump drive with multi-heads can fulfill a diverse range of pumping applications. The following table lists the single and multi-channel pump head options for the MCP/BVP drives with page references to the available tubing.

Catalog No.	$	Product
Select Pump Head		
Single Channel, see pages A55 and A56		
BS4 73-3035		380AD
BS4 73-3119		Pro-280
BS4 73-3120		Pro-380
BS4 73-3121		Pro-281
BS4 73-3122		Pro-381
Multi Channel, see pages A57 to A59		
BS4 73-3031		CA-4
BS4 73-3036		CA-8
BS4 73-3037		CA-12
BS4 73-3040		SB (Requires Tube Bed Set)
BS4 73-3030		MS3
BS4 73-3038		MS/CA4-12
BS4 73-3033		MS/CA8-6

Gentle Pumping Pump Heads

BS4 73-3119

BS4 73-3120

These pumps heads provide gentle pumping action and are suitable for many applications, including cell suspensions.

The model Pro-280 pump head is gentle enough to use for highly viscous liquids with concentrated viable cells. Comparisons to gear, piston and centrifugal pumps proved that peristaltic pumps are the only suitable and sterilizable pump system for gently pumping media containing living cells.

- Unique convex rollers cause minimal cell lysis
- Ideal for mammalian cell inoculating, harvesting, or cell suspension transfers
- Elevated differential pressures (Pro-281 and Pro-381)
- Suitable for viscous fluids and fluids containing a high content of sensitive solids
- Applications requiring hygienic conditions, durability and reliability
- Installs rapidly
- Easily interchanged with other MCP/BVP pump heads

Specifications

Catalog No	$	Pump Head	# Channels	# Rollers	Tubing Wall Thickness	Flow Rate Range, ml/min
BS4 73-3119		Pro-280	1	2	1.6 mm	0.49 to 3700
BS4 73-3120		Pro-380	1	3	1.6 mm	0.45 to 3400
BS4 73-3121		Pro-281	1	2	2.4 mm	3.6 to 3100
BS4 73-3122		Pro-381	1	3	2.4 mm	3.3 to 2900

Flow Rates for Gentle Pumping Pump Heads

Standard Tygon® R-3603/R-3607 Tubing		Pro-280 Flow Rate, ml/min		Pro-380 Flow Rate, ml/min	
ID mm	Wall mm	Minimum	Maximum	Minimum	Maximum
1.6	1.6	0.49	120	0.45	110
3.2	1.6	1.9	450	1.7	400
4.8	1.6	4.2	1000	3.7	890
6.4	1.6	7.2	1700	6.5	1600
9.5	1.6	14	3300	13	3000
11.1	1.6	16	3700	14	3400

Standard Tygon® R-3603/R-3607 Tubing		Pro-281 Flow Rate, ml/min		Pro-381 Flow Rate, ml/min	
ID mm	Wall mm	Minimum	Maximum	Minimum	Maximum
4.8	2.4	3.6	870	3.3	800
6.4	2.4	6.5	1600	5.8	1400
8	2.4	9.9	2400	8.8	2100
9.5	2.4	13	3100	12	2900

Pro-280

- Coated aluminum pump-head
- Can be dismantled for cleaning
- Stainless steel rollers
- Self-centering tube-track, allows tube to lie in the optimum position, which considerably lengthens the tube-life
- For applications which require hygienic conditions, reliability and durability
- Ideal for use in chemical, biotechnological and pharmaceutical processes and in food industry

Pro-281

- Same as Pro-280 but
- For tubing with 2.4 mm wall thickness
- Especially recommended for:
  - Elevated differential pressures
  - Viscous fluids

Pro-380

- Same as Pro-280 but
- Less pulsation thanks to 3 rollers
- Slightly lower flow rate

Pro-381

- Same as Pro-380 but
- For tubing with 2.4 mm wall thickness
- Especially recommended for:
  - Elevated differential pressures
  - Viscous fluids

These pump heads use Standard Pump Tubing, see page A63.

Pump Head 380AD

BS4 73-3035

Single-Channel
Pump Head 380AD

- Installs rapidly
- Easily interchanged with other MCP/BVP pump heads
- Ideal for chemical, biotechnological and pharmaceutical applications
- Suitable for viscous fluids and fluids containing a high content of sensitive solids
- Applications requiring hygienic conditions, durability and reliability

This pump head features 3 convex rollers revolving in a concave tube bed which allows cells or particles to escape through a gap towards tubing wall to minimize damage. It is ideal for inoculating or harvesting mammalian cells.

Adjustable Pump Rollers

On this pump-head, the 3 convex rollers can be adjusted and pressed symmetrically against the concave tube-bed, enabling the use of pump tubing with various wall thicknesses.

Please note:

The listed flow-rates are approximate values in ml/min. They have been determined under the following conditions:

- Medium: water
- Temperature: 22˚C
- No back-pressure
- Pump tubing: Tygon®

The exact flow-rate depends on a number of parameters including quality and age of the tubing, pressure onto the tube-bed (adjustable), back-pressure, viscosity of fluid, temperature, etc.

Adjustable roller pressure accomodates wide range of tubing durometers (stiffness).

Very simple tube-loading. This pump-head accepts tubing with different diameters and wall thicknesses with ease. Thanks to the adjustable pump rollers, this is an ideal pump-head for media with high viscosity, or with a certain level of solid content.

Specifications

Pump Head	380AD
Channels	1
Pump Rollers	3
Flow Rates	0.41 to 3600 ml/min
Back Pressure	1.5 bar (22 PSI) maximum with 1.6 mm wall thickness tubing 2.5 bar (36 PSI) maximum with 2.4 mm wall thickness tubing
Tubing Type	Standard Tubing
Tubing ID	0.8 to 11.1 mm; 4.8 to 6.4 mm
Tubing Wall Thickness	1.6 mm or 2.4 mm

Flow Rates for 380AD Pump Head Using Standard Tubing

Tubing ID	Wall Thickness	Flow Rates, ml/min Minimum	Maximum
0.8 mm	1.6 mm	–	–
1.6 mm	1.6 mm	0.41	99
3.2 mm	1.6 mm	1.5	370
4.8 mm	1.6 mm	3.4	830
6.4 mm	1.6 mm	6.2	1500
8.0 mm	1.6 mm	9.5	2300
9.5 mm	1.6 mm	13	3000
11.1 mm	1.6 mm	15	3600
4.8 mm	2.4 mm	3.4	830
6.4 mm	2.4 mm	6.2	1500

Catalog No.	$	Product
BS4 73-3035		380AD Single-Channel Pump Head for MCP/BVP Pump Drive

This pump head uses Standard Pump Tubing, see page A63.

SB Pump Head with Tube Bed Sets, 2V or 3V

SB Pump Head with Tube Bed Sets, suitable to MCP and BVP drives

Single pump head with interchangeable two or three channel tube bed sets.

Insert..., rotate..., ready to use, it's that simple!

For use with MCP and BVP Pump Drives, see pages A53 and A54.

SB Pump Head with 2V Tube Bed Set

- Ideal for sensitive substances requiring a smooth pressure adjustment
- Uses Spring-loaded Tube Bed Set – choice of 2 or 3 Channels
- Tube Bed Sets are interchangeable
- 0.009 to 1100 ml/min Flow Rates depending on Tube Bed Set
- 6 Rollers
- Individual and continuously adjustable pressure setting per channel
- Back Pressure has maximum of 1.5 bar (22 PSI)

Specifications

Pump Head	SB
Tube Bed Set	2V
Channels	1 – 2
Pump Rollers	6
Flow Rates	1.1 to 1100 ml/min
Back Pressure	1.5 bar (22 PSI) maximum
Tubing Type	Standard tubing
Tube ID	3.2 to 8.0 mm
Tubing Wall Thickness	1.6 mm

SB Pump Head with 3V Tube Bed Set

Specifications

Pump Head	SB
Tube Bed Set	3V
Channels	1 – 3
Pump Rollers	6
Flow Rates	0.09 to 870 ml/min
Back Pressure	1.5 bar (22 PSI) maximum
Tubing Type	Standard tubing
Tube ID	0.8 to 6.4 mm
Tubing Wall Thickness	1.6 mm

Flow Rates for SB Pump Head using Standard Tubing, 1.6 mm Wall Thickness

Standard Tubing ID mm	2V Tube Bed Set ml/min min	2V Tube Bed Set ml/min max	3V Tube Bed Set ml/min min	3V Tube Bed Set ml/min max
0.8	—	—	0.09	22
1.6	—	—	0.26	63
3.2	1.1	260	0.99	240
4.8	2.3	550	2.2	530
6.4	3.7	890	3.6	870
8.0	4.6	1100	—	—

Note: For BVP-Standard drive, the min. flow rate values must be multiplied by factor 2.4

Catalog No.	$	Product
BS4 73-3040		SB Pump Head for BVP/MCP Pump Drive*
BS4 73-3045		2V Tube Bed Set for SB Pump Head
BS4 73-3046		3V Tube Bed Set for SB Pump Head

**Note: Requires selection of Tube Bed Set.*

These Tube Bed Sets use Standard Pump Tubing, see page A63.

4, 8, and 12 Channel Pump Heads for MCP and BVP Pump Drives

BS4 73-3031

CA-4 Pump Head

BS4 73-3036

CA-8 Pump Head

BS4 73-3037

CA-12 Pump Head

- For use with MCP and BVP Pump Drive, see pages A53 and A54
- Cassettes are included
- Use CA Click 'n' Go Cassettes, see page A60, cassettes are included
- Automatic pressure setting
- Easy and rapid tube change-over; each channel separately, even while pump is running
- 8 rollers
- 4, 8, or 12 channels, each channel can take different tube sizes
- Use 2-stop collared tubing 0.13 to 3.17 mm ID, see page A62
- 0.002 to 230 ml/min flow rate range

The CA pump heads for the MCP/BVP pump drives, see pages A53 and A54, offer the widest flow rate range of any multi-channel pump head series available.

Other multi-channel pump heads include the MS/CA 4-12 and 8-6, see page A59. The MS/CA 4-12 and 8-6 multi-channel pump head series offer 12 or 6 rollers, respectively, and stackable head assemblies that allow you to increase the number of tubing channels per pump drive.

Flow Rate Range for CA Pump Heads

	2-Stop Collared Tubing		
	Tubing	ml/min per Channel	
ENE#	ID mm	Minimum	Maximum
00	0.13	0.002	0.31
01	0.19	0.004	0.94
02	0.25	0.008	1.8
03	0.38	0.019	4.5
04	0.44	0.025	6.1
05	0.51	0.034	8.2
06	0.57	0.042	10
07	0.64	0.053	13
08	0.76	0.074	18
09	0.89	0.1	24
10	0.95	0.11	27
11	1.02	0.13	31
12	1.09	0.14	35
13	1.14	0.16	38
14	1.22	0.18	42
15	1.3	0.2	47
16	1.42	0.23	55
17	1.52	0.26	62
18	1.65	0.3	71
19	1.75	0.33	78
20	1.85	0.36	86
21	2.06	0.43	100
22	2.29	0.51	120
23	2.54	0.62	150
24	2.79	0.74	180
25	3.17	0.94	230

Note: For BVP-Standard drive, the minimum flow rate values must be multiplied by factor 2.4.

Specifications

Pump Rollers	8
Flow Rates	0.002 to 230 ml/min
Back Pressure	1.0 bar maximum
Tubing Type	2-Stop Collared Tubing
Tubing ID	0.13 to 3.17 mm

Catalog No.	$	Product
BS4 73-3031		CA-4 Pump Head 4 Channel for BVP/MCP Pump Drives
BS4 73-3036		CA-8 Pump Head 8 Channel for BVP/MCP Pump Drives
BS4 73-3037		CA-12 Pump Head 12 Channel for BVP/MCP Pump Drives
BS4 73-3052		Replacement CA Cassette, Click 'n' Go

These pump heads use 2-Stop Collared Tubing, see page A62.

MS Multi-Channel Pump Heads for MCP and BVP Pump Drives

BS4 73-3030

MS-3 Pump Head

- For use with MCP and BVP Pump Drives, see pages A53 and A54
- Ideal for sensitive substances requiring a gentle pressure setting
- Uses spring-loaded tube bed set
- Transparent protection cover for easy monitoring of the pump head
- Easy and rapid tube change-over
- 3 channels
- 6 rollers
- 0.002 to 100 ml/min flow rates
- Uses 3-stop collared tubing, 0.13 to 3.17 mm ID, see page A61
- Back pressure has max of 1.5 bar (22 PSI)

Catalog No.	$	Product
BS4 73-3030		MS-3 Pump Head for BVP/MCP Pump Drives

BS4 73-3038

MS/CA 4-12 Pump Head

- For use with MCP and BVP Pump Drives, see pages A53 and A54
- MS/CA Click 'n' Go Cassettes are included
- 12 Rollers for extremely low pulsation
- 4 channels, extendable to 8, 12, or 16 channels
- 3 extension blocks with 4 channels each
- Each channel can take different tube sizes
- Easy and rapid tube change-over; even while pump is running
- 0.001 to 57 ml/min flow rates
- Uses 3-stop collared tubing, 0.13 to 3.17 mm ID, see page A61
- Back pressure has maximum of 1.0 bar (14.5 PSI)

Catalog No.	$	Product
BS4 73-3038		MS/CA 4-12 Pump Head for BVP/MCP Pump Drives
BS4 73-3039		MS/CA 4-12 Extension Block, 4 Channel

BS4 73-3033

MS/CA 8-6 Pump Head

- For use with MCP and BVP Pump Drives, see pages A53 and A54
- MS/CA Click 'n' Go Cassettes are included
- 8 channels, extendable to 16 or 24 channels
- 2 extension blocks with 8 channels each
- Each channel can take different tube sizes
- Easy and rapid tube change-over; even while pump is running
- 6 rollers
- 0.002 to 100 ml/min Flow Rates
- Uses 3-stop collared tubing, 0.13 to 3.17 mm ID, see page A61
- Back pressure has maximum of 1.0 bar (14.5 PSI)

Catalog No.	$	Product
BS4 73-3033		MS/CA 8-6 Pump Head for BVP/MCP Pump Drives
BS4 73-3034		MS/CA 8-6 Extension Block, 8 Channel

Flow Rate Range for MS and MS/CA Cassettes

3-Stop Collared Tubing ID mm	MS-3 3 Channels BS4 73-3030 Flow Rates ml/min per channel min.	max.	MS/CA 4-12 4, 8, 12, or 16 Channels BS4 73-3038 Flow Rates ml/min per channel min.	max.	MS/CA 8-6 8, 16, or 24 Channels BS4 73-3033 Flow Rates ml/min per channel min.	max.
0.13	0.002	0.4	0.001	0.22	0.002	0.33
0.19	0.003	0.73	0.003	0.51	0.003	0.67
0.25	0.005	1.2	0.004	0.91	0.005	1.1
0.38	0.011	2.6	0.009	2.1	0.011	2.6
0.44	0.014	3.4	0.012	2.8	0.014	3.5
0.51	0.019	4.5	0.016	3.8	0.019	4.6
0.57	0.023	5.5	0.019	4.7	0.024	5.7
0.64	0.029	6.9	0.024	5.8	0.03	7.2
0.76	0.04	9.6	0.033	8	0.042	10
0.89	0.053	13	0.044	11	0.057	14
0.95	0.06	14	0.05	12	0.064	15
1.02	0.069	17	0.056	13	0.073	18
1.09	0.078	19	0.063	15	0.083	20

Note: For BVP-Standard drive, the min. flow rate values must be multiplied by factor 2.4

Flow Rate Range for MS and MS/CA Cassettes

3-Stop Collared Tubing ID mm	MS-3 3 Channels BS4 73-3030 Flow Rates ml/min per channel min.	max.	MS/CA 4-12 4, 8, 12, or 16 Channels BS4 73-3038 Flow Rates ml/min per channel min.	max.	MS/CA 8-6 8, 16, or 24 Channels BS4 73-3033 Flow Rates ml/min per channel min.	max.
1.14	0.084	20	0.067	16	0.09	22
1.22	0.1	23	0.075	18	0.1	24
1.3	0.11	26	0.083	20	0.11	27
1.42	0.12	30	0.094	23	0.13	32
1.52	0.14	34	0.1	25	0.15	36
1.65	0.16	39	0.12	28	0.17	42
1.75	0.18	42	0.13	30	0.19	46
1.85	0.19	47	0.13	32	0.21	50
2.06	0.23	55	0.15	37	0.25	59
2.29	0.27	65	0.17	41	0.29	69
2.54	0.32	76	0.19	46	0.33	79
2.79	0.36	87	0.21	52	0.37	89
3.17	0.42	100	0.24	57	0.43	100

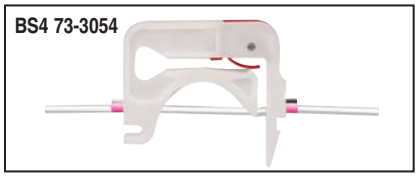
Note: For BVP-Standard drive, the min. flow rate values must be multiplied by factor 2.4

Tubing Cassettes and Accessories

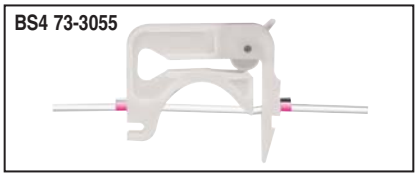
BS4 73-3052

BS4 73-3053

BS4 73-3054



BS4 73-3055



Click 'n' Go Cassettes

Supplied standard with all ISMATEC cassette pumps, these new, innovative tubing cassettes offer the following advantages:

- Automatic pressure mechanism to set tubing pressure
- Calibrated, fatigue-free spring guarantees optimal, reproducible tubing pressure independent of diameter, material and state of tubing
- Long term channel-to-channel conformity

These cassettes are not suitable for Tygon® MH2075 tubing (or other hard tubing materials) or for differential pressure greater than 1 bar (14.5 PSI). Pressure lever cassettes are recommended for these conditions.

Catalog No.	$	Product
BS4 73-3054		MS/CA Cassette, Click 'n' Go
BS4 73-3052		CA Cassette, Click 'n' Go
BS4 73-3303		Spare POM-C Adaptor for CA Cassettes

Pressure Lever Cassettes

The Pressure Lever Cassettes are designed to allow the user to set a different tubing pressure for each channel. This adjustment allowed an optimal tubing pressure to be set depending on the tubing material and diameter as well as the application. Since it may be necessary to periodically adjust the tubing pressure to maintain constant flow rates, these successful cassettes are now available as an option rather than supplied standard. These cassettes are still recommended over the automatic Click 'n' Go cassettes under the following conditions:

- Varying or high differential pressure
- For hard tubing material, such as Tygon® MH2075

Catalog No.	$	Product
BS4 73-3055		MS/CA Cassette, Pressure Lever
BS4 73-3053		CA Cassette, Pressure Lever
BS4 73-3303		Spare POM-C Adaptor for CA Cassettes

Pump Accessories

Pg. #	Pump Model	Footswitch	$	Cassette Type*	Catalog No.	$
A46	REGLO Digital	BS4 73-3050		MS/CA CNG	BS4 73-3054	
A48	REGLO Analog	BS4 73-3049		MS/CA CNG	BS4 73-3054	
A52	Ecoline VC-MS/CA8-6	BS4 73-3051		MS/CA CNG	BS4 73-3054	
A52	Ecoline VC-MS/CA4-12	BS4 73-3051		MS/CA CNG	BS4 73-3054	
A45	Ecoline VC-280, VC-380	BS4 73-3051		Exchangeable Rotors		
A45	Ecoline VC-360	BS4 73-3051		N/A		
A50	IP, IP-N	BS4 73-3048		CA CNG	BS4 73-3052	
A50	IPC, IPC-N	BS4 73-3048		CA CNG	BS4 73-3052	
A53	MCP	BS4 73-3048		Depends on pump head		
A54	BVP	BS4 73-3049		Depends on pump head		

CNG = Click 'n' Go

Foot Switches

Foot switches provide the start/stop signal required for the pump. This accessory is very practical for use with dispensing systems such as those required for filling tubes or bottles.

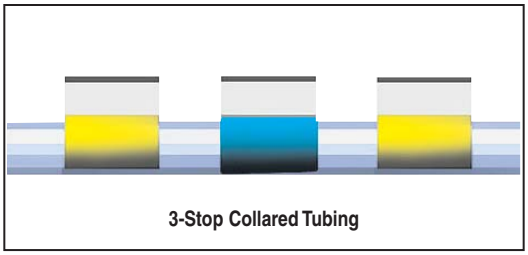
Catalog No.	$	Product
BS4 73-3048		Foot Switch for MCP, IP, IPC, IP-N, IPC-N
BS4 73-3049		Foot Switch for BVP and REGLO Analog Pumps
BS4 73-3050		Foot Switch for REGLO Digital Pumps
BS4 73-3051		Foot Switch for Ecoline Pumps

Rotors for Ecoline VC-280 and VC-380 Pumps, see page A45

Catalog No.	$	Product
BS4 73-3114		Rotor, 3 Rollers, Black, Accepts 2.4 mm Tubing Wall Thickness
BS4 73-3115		Rotor, 2 Rollers, Black, Accepts 2.4 mm Tubing Wall Thickness
BS4 73-3116		Rotor, 2 Rollers, Red, Accepts 1.6 mm Tubing Wall Thickness
BS4 73-3117		Rotor, 3 Rollers, Red, Accepts 1.6 mm Tubing Wall Thickness

3-Stop Collared Tygon® Pump Tubing for MS/CA Cassettes

This is 3-stop collared TYGON® tubing is for use with the REGLO Pumps and other pumps. Each length of tubing measures 400 mm (15.7 in). Either 12 or 6 lengths are supplied per package. Select your required tubing size and tubing material from the chart below. The distance between the collars is 73 mm (2.9 in). The tubing is available in four different materials. Select the material based on your application.



3-Stop Collared Tubing

3-Stop Collared Tubing is required for the following:

Pumps

- All REGLO Digital, see page A46
- All REGLO Analog, see page A48
- Ecoline MS/CA8-6, see page A52

Pump Heads

- MS-3, see page A59
- MS/CA 4-12, see page A59
- MS/CA 8-6, see page A59

For 2-Stop Collared Tubing, see page A62.

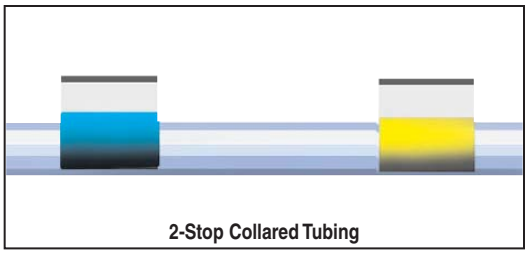
For Standard Tubing, see page A63.

3-Stop Collared Pump Tubing for REGLO and Other Pumps

AME#	ID	Color Code	Tygon® ST R-3606/R-3607 Catalog No.	$	Tygon® LFL Catalog No.	$	Tygon® SI Silicone 3350 Catalog No.	$	PharMed Ismaprene Catalog No.	$
00	0.13 mm	orange-black	BS4 73-1816		–	–	–	–	–	–
01	0.19 mm	orange-red	BS4 73-1817		–	–	–	–	–	–
02	0.25 mm	orange-blue	BS4 73-1818		BS4 73-3214		–	–	BS4 73-3175	
03	0.38 mm	orange-green	BS4 73-1819		BS4 73-3215		–	–	BS4 73-3176	
04	0.44 mm	green-yellow	BS4 73-1820		–	–	–	–	–	–
05	0.51 mm	orange-yellow	BS4 73-1821		BS4 73-3216		BS4 73-3262		BS4 73-3177	
06	0.57 mm	white-yellow	BS4 73-1822		–	–	–	–	–	–
07	0.64 mm	orange-white	BS4 73-1823		BS4 73-3217		BS4 73-3263		BS4 73-3178	
08	0.76 mm	black-black	BS4 73-1824		BS4 73-3218		BS4 73-3264		BS4 73-3179	
09	0.89 mm	orange-orange	BS4 73-1825		BS4 73-3219		BS4 73-3265		BS4 73-3180	
10	0.95 mm	white-black	BS4 73-1826		–	–	–	–	–	–
11	1.02 mm	white-white	BS4 73-1827		BS4 73-3220		BS4 73-3266		BS4 73-3181	
12	1.09 mm	white-red	BS4 73-1828		–	–	–	–	–	–
13	1.14 mm	red-red	BS4 73-1829		BS4 73-3221		BS4 73-3267		BS4 73-3182	
14	1.22 mm	red-grey	BS4 73-0126		–	–	–	–	–	–
15	1.3 mm	grey-grey	BS4 73-1830		BS4 73-3222		BS4 73-3268		BS4 73-3183	
16	1.42 mm	yellow-yellow	BS4 73-1831		BS4 73-3223		BS4 73-3269		BS4 73-3184	
17	1.52 mm	yellow-blue	BS4 73-1832		BS4 73-3224		BS4 73-3270		BS4 73-3185	
18	1.65 mm	blue-blue	BS4 73-1833		BS4 73-3225		BS4 73-3271		BS4 73-3186	
19	1.75 mm	blue-green	BS4 73-1834		–	–	–	–	–	–
20	1.85 mm	green-green	BS4 73-1835		BS4 73-3226		BS4 73-3272		BS4 73-3187	
21	2.06 mm	purple-purple	BS4 73-1836		BS4 73-3227		BS4 73-3273		BS4 73-3188	
22	2.29 mm	purple-black	BS4 73-1837		BS4 73-3228		BS4 73-3274		BS4 73-3189	
23	2.54 mm	purple-orange	BS4 73-1838		BS4 73-3229		BS4 73-3275		BS4 73-3190	
24	2.79 mm	purple-white	BS4 73-0155		BS4 73-3230		BS4 73-3276		BS4 73-3191	
25	3.17 mm	black-white	BS4 73-1839		–	–	–	–	–	–
	Pack Size		12 pieces		12 pieces		6 pieces		6 pieces	

2-Stop Tygon® Pump Tubing for CA Cassettes

This is 2-stop collared Tygon® tubing. Each length of tubing measures 400 mm (15.7 in). Either 12 or 6 lengths are supplied per package. Select your required tubing size and tubing material from the chart below. The distance between the collars is 153 mm (6.1 in). The tubing is available in four different materials. Select the material based on your application.



2-Stop Collared Tubing

2-Stop Collared Tubing is required for the following:

Pumps

- IP, IPC, IP-N, IPC-N, see page A50

Pump Heads

- CA-4, see page A58
- CA-8, see page A58
- CA-12, see page A58

For 3-Stop Collared Tubing, see page A61.

For Standard Tubing, see page A63.

2-Stop Collared Pump Tubing

Tubing ID	Color Code	Tygon® ST R-3606/R-3607 Catalog No.	$	Tygon® LFL Catalog No.	$	Tygon® SI Silicone 3350 Catalog No.	$	PharMed Ismaprene Catalog No.	$
0.13 mm	orange-black	BS4 73-3174		–	–	–	–	–	–
0.19 mm	orange-red	BS4 73-1840		–	–	–	–	–	–
0.25 mm	orange-blue	BS4 73-1841		BS4 73-3231		–	–	BS4 73-3192	
0.38 mm	orange-green	BS4 73-1842		BS4 73-3232		–	–	BS4 73-3193	
0.44 mm	green-yellow	BS4 73-1843		–	–	–	–	–	–
0.51 mm	orange-yellow	BS4 73-1844		BS4 73-3233		BS4 73-3277		BS4 73-3194	
0.57 mm	white-yellow	BS4 73-1845		–	–	–	–	–	–
0.64 mm	orange-white	BS4 73-1846		BS4 73-3234		–	–	BS4 73-3195	
0.76 mm	black-black	BS4 73-1847		BS4 73-3235		BS4 73-3278		BS4 73-3196	
0.89 mm	orange-orange	BS4 73-1848		BS4 73-3236		BS4 73-3279		BS4 73-3197	
0.95 mm	white-black	BS4 73-1849		–	–	–	–	–	–
1.02 mm	white-white	BS4 73-1850		BS4 73-3237		BS4 73-3280		BS4 73-3198	
1.09 mm	white-red	BS4 73-1851		–	–	–	–	–	–
1.14 mm	red-red	BS4 73-1852		BS4 73-3238		BS4 73-3281		BS4 73-3199	
1.22 mm	red-grey	BS4 73-1853		–	–	–	–	–	–
1.3 mm	grey-grey	BS4 73-1854		BS4 73-3239		BS4 73-3282		BS4 73-3200	
1.42 mm	yellow-yellow	BS4 73-1855		BS4 73-3240		BS4 73-3283		BS4 73-3201	
1.52 mm	yellow-blue	BS4 73-1856		BS4 73-3241		BS4 73-3284		BS4 73-3202	
1.65 mm	blue-blue	BS4 73-1857		BS4 73-3242		BS4 73-3285		BS4 73-3203	
1.75 mm	blue-green	BS4 73-1858		–	–	–	–	–	–
1.85 mm	green-green	BS4 73-1859		BS4 73-3243		BS4 73-3286		BS4 73-3204	
2.06 mm	purple-purple	BS4 73-1860		BS4 73-3244		BS4 73-3287		BS4 73-3205	
2.29 mm	purple-black	BS4 73-1861		BS4 73-3245		BS4 73-3288		BS4 73-3206	
2.54 mm	purple-orange	BS4 73-1862		BS4 73-3246		BS4 73-3289		BS4 73-3207	
2.79 mm	purple-white	BS4 73-1863		BS4 73-3247		BS4 73-3290		BS4 73-3208	
3.17 mm	black-white	BS4 73-1864		–	–	–	–	–	–
Pack Size		12 pieces		12 pieces		6 pieces		6 pieces	

Tygon® Standard Pump Tubing

This tubing is offered in 4 varieties. Select the tubing material based on your application. It is supplied in either 7.5 or 15 meter lengths.

Standard Tubing is required for the following:

Pumps

- Ecoline VC-280, see page A45
- Ecoline VC-380, see page A45
- Ecoline VC-360, see page A45
- Ecoline VC-Easy-Load, see page A45

Pump Heads

- Pro-280, see page A55
- Pro-380, see page A55
- Pro-281, see page A55
- Pro-381, see page A55
- 380AD, see page A56
- SB-2V, see page A57

For 3-Stop Collared Tubing, see page A61.

For 2-Stop Collared Tubing, see page A62.

Standard Pump Tubing

Tubing ID	Wall Thickness	Tygon® ST R-3606/R-3607 Catalog No.	$	Tygon® LFL Catalog No.	$	Tygon® SI Silicone 3350 Catalog No.	$	PharMed Ismaprene Catalog No.	$
0.8 mm	1.6 mm	**BS4 73-1806**		–	–	–	–	**BS4 73-3168**	
1.6 mm	1.6 mm	**BS4 73-1807**		**BS4 73-3209**		**BS4 73-3255**		**BS4 73-3169**	
3.2 mm	1.6 mm	**BS4 73-1808**		**BS4 73-3210**		**BS4 73-3256**		**BS4 73-3171**	
4 mm	1.6 mm	**BS4 73-3248**		–	–	–	–	–	–
4.8 mm	1.6 mm	**BS4 73-1809**		**BS4 73-3211**		**BS4 73-3257**		**BS4 73-3170**	
6.4 mm	1.6 mm	**BS4 73-1810**		**BS4 73-3212**		**BS4 73-3259**		**BS4 73-3172**	
8 mm	1.6 mm	**BS4 73-1811**		**BS4 73-3213**		**BS4 73-3261**		**BS4 73-3173**	
9.5 mm	1.6 mm	**BS4 73-1814**		–	–	–	–	–	–
11.1 mm	1.6 mm	**BS4 73-1815**		–	–	**BS4 73-3291**		–	–
4.8 mm	2.4 mm	**BS4 73-1812**		–	–	**BS4 73-3258**		–	–
6.4 mm	2.4 mm	**BS4 73-1813**		–	–	**BS4 73-3260**		–	–
8 mm	2.4 mm	**BS4 73-3249**		–	–	**BS4 73-3252**		–	–
9.5 mm	2.4 mm	**BS4 73-3250**		–	–	**BS4 73-3253**		–	–
11.1 mm	2.4 mm	**BS4 73-3251**		–	–	**BS4 73-3254**		–	–
Length Supplied		15 m		7.5 m		15 m		7.5 m	

TPM Variable Speed Transfer/Metering Peristaltic Pump

- Economical transfer pump
- Simple and reliable continuous delivery of fluids
- Available in single channel and multi-channel models
- Accommodates a wide range of tubing sizes and types to handle all of your laboratory needs

The TPM peristaltic pump is a basic, economical peristaltic pump used when simple metering or transferring of fluids up to 2.2 L/min is required. The outer casing has a sanitary chemical and knock resistant finish suited for the research environment.

Two models are available; a low flow pump (2.75 to 55 RPM) for precision at lower flow rates and a high flow model (11 to 220 RPM) for a wider flow rate range. These models feature a two roller pump head which accepts tubing with of 0.5 to 5/16 in OD and 1/32 to 3/32 in wall thickness. The spring loaded roller assembly works well with a variety of tubing styles, but is more pulsatile than the 4 roller multichannel version.

For multi-channel applications and/or lower flow rate ranges several 5-channel models are available. These 5-channel models are available in either low or high flow versions. The 4 roller multi-channel TPM is suitable for most laboratory applications.

The single channel TPM can be upgraded to a 5-channel pump by adding a BS4 72-0617, Multi-Channel Adapter and either a 4 or 8 roller, 5 channel pump head, BS4 72-0600 or BS4 72-0603, respectively.

Flow Rate for TPM Pump

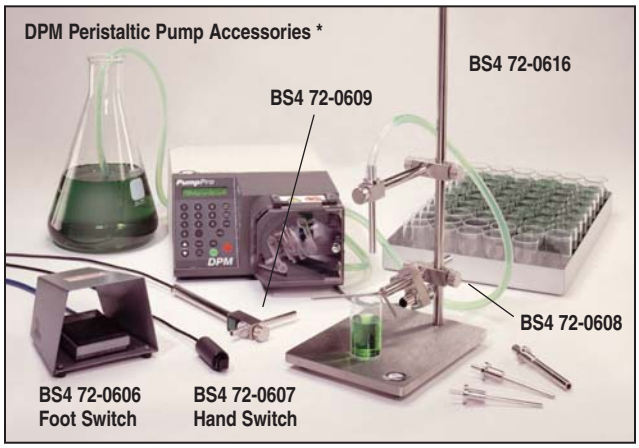
Tube Size (mm, in)[A]	0.5, 1/50	0.8, 1/32	1.6, 1/16	3.2, 1/8	4.8, 3/16	6.4, 1/4	8.0, 5/16
2.75 to 55 rpm[B]	0.1-2.3	0.4-6.7	1.2-24	5-101	11-220	17-347	28-550
11 to 220 rpm[C]	0.5-9.2	1.4-27	4.7-94	21-410	45-892	70-1400	110-2200

A. Tube internal diameters in mm and in. Tube wall thickness is 1.6 mm 1/16 in.
B. Rates are min - max (ml/sec) for the TPM low flow pump for 7 different tube IDs
C. Rates are min - max (ml/sec) for the TPM high flow pump for 7 different tube IDs

Specifications

Speed Range:	1 to 20 RPM
Low Flow	2.75 to 55 RPM
High Flow	11 to 220 RPM
Voltage	110 to 240 VAC, 50-60 Hz
Standards	IEC 335-1, EN60529 (IP31), CE
Dimensions, H x W x D	12.5 x 18.5 x 30 cm (5 x 7.25 x 11.75 in)
Shipping Weight	5 kg (10 lb)

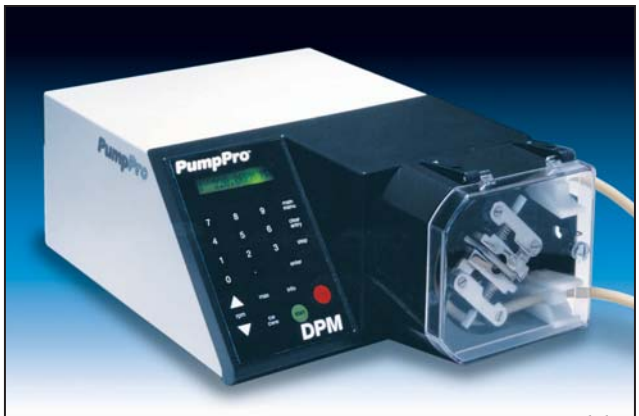
Catalog No.	$	Product
BS4 72-0596		TPM Pump, Low Flow, 2.75 to 55 RPM
BS4 72-0597		TPM Pump, High Flow, 11 to 220 RPM
BS4 72-0598		5-Channel/4-Roller TPM Pump, Low Flow
BS4 72-0599		5-Channel/4-Roller TPM, High Flow
BS4 72-0604		Replacement Cartridge, for multi-channel pumps
BS4 72-0617		Adapter, TPM Single to TPM Multi
BS4 72-0600		5-Channel/4-Roller Extension Pumphead
BS4 72-0603		5-Channel/8-Roller Extension Pumphead



** Note: see page A65 for product description*

For Multi-Channel Tubing Sets, see page A67.

DPM Dispensing & Transfer Peristaltic Pump



DPM Dispensing and Transfer Peristaltic Pump

- Can be used for:
  - — Dispensing aliquots
  - — Filling vials
  - — Batch transfers
- Menu driven for easy operation
- Soft start and stop reduces splashing
- End-of-dose reversing prevents drips
- Wide flow rate range (100:1)
- Compatible with a wide range of tubing sizes and materials

The DPM Pump is designed for precise fluid dispensing or transfer at flow rates up to 3.0 L/min. It is controlled via a membrane keypad. It is menu-driven to easily enter the dose size, and calibration information in milliliters or grams. The DPM has a ramp feature that softly starts and stops the pump to prevent splashing, and an end-of-dose reversing feature that prevents dripping. Calibration is easy, using resident values based on the tube size, or you can calibrate by actual dispense weight or volume. 'On the fly' calibration allows quick recalibration without batch interruption. Works with all peristaltic pump compatible tubing with a wall thickness of 1.59 mm (1/16 in). See the Tubing Section on pages A78 to A87 for more details.

Two different modes of operation are available: dispense mode and manual mode. In Dispense Mode, the dispense is set up by specifying required volume, number of dispenses, and pump speed. The pump can be set to dose after a time interval or by initiation from a foot switch or other device. Manual Mode is used for continuous metering or transfer. When used in manual mode, the pump has a 100:1 flow range of 0.1 ml/min to 3.0 L/min. The display can be toggled to read as either RPM or flow rate.

BS4 72-0610
Boxed Set of Filling Needles

Flow Rate for DPM Pump

Tube Size (mm, in)[A]	0.5, 1/50	0.8, 1/32	1.6, 1/16	3.2, 1/8	4.8, 3/16	6.4, 1/4	8.0, 5/16
ml/sec[B]	0.21	0.62	2.13	9.33	20.2	31.7	50.0

Accuracy (min dispense (ml) based on accuracy required vs. tube bore)

Tube No.	0.5, 1/50	0.8, 1/32	1.6, 1/16	3.2, 1/8	4.8, 3/16	6.4, 1/4	8.0, 5/16
± 0.5%	0.67	1.92	6.9	29.8	65	102	160
±1.0%	0.38	1.08	3.9	16.7	36	57	90
± 2.0%	0.17	0.48	1.7	7.4	16	25	40

Transfer Flow Rate (ml/min)

Tube Size (mm, in)[A]	0.5, 1/50	0.8, 1/32	1.6, 1/16	3.2, 1/8	4.8, 3/16	6.4, 1/4	8.0, 5/16
Min	0.1	0.4	1.3	5.6	12.0	19.0	30.0
Max[B]	12.5	37.0	128	560	1210	1900	3000

A. Tube internal diameters in mm and in. Tube wall thickness is 1.6 mm (1/16 in).
B. Rates are max flow (300 rpm) in ml/sec for 7 different tube IDs

Specifications

Speed Range	3 to 300 RPM
Voltage	100 to 120 VAC/220 to 240 VAC, 50/60 Hz (switchable)
Standards	IEC 335-1, EN60529 (IP31), EC
Dimensions, H x W x D	12 x 22 x 32 cm (4.75 x 8.75 x 12.63 in)
Shipping Weight	9 kg (20 lb)

Catalog No.	$	Product
BS4 72-0605		DPM Dispensing and Transfer Pump
BS4 72-0606		Foot Switch*
BS4 72-0607		Hand Switch*
BS4 72-0616		Filling Stand.* A heavy-duty stainless steel ring stand which has a needle holder, and guide to center a vial under a dispensing needle during filling.
BS4 72-0608		Proximity Switch (stainless steel construction).* An automatic sensor that mounts to the filling stand and triggers a dose dispense once a vial is placed under the dispensing needle.
BS4 72-0610		Boxed Set of Filling Needles (set of 5). Stainless steel needles in 5 different sizes to accommodate the various tube sizes available. The needle is mounted in the filling stand and the tube is connected to the needle.
BS4 72-0611		Filling Needle, 1.6 mm bore
BS4 72-0612		Filling Needle, 3.2 mm bore
BS4 72-0613		Filling Needle, 4.8 mm bore
BS4 72-0614		Filling Needle, 6.4 mm bore
BS4 72-0615		Filling Needle, 8.0 mm bore
BS4 72-0609		Dispensing Lance (stainless steel construction). Replaces the filling stand needle holder and has a switch on the end to start the dose. The Lance can also be hand-held to direct the needle over any container and the dispense is initiated by pressing the thumb activated switch.

** See photo, page A64.*

MPL Multi-Channel Peristaltic Pump

- Eight roller pumphead
- Very low pulsation
- Low-speed (0.1 RPM) standby mode keeps tubing lines open
- Select from 4-, 8-, 12-, and 16-channel pumps
- Both manual and manual/analog versions available
- Extension pump heads increase the number of channels (maximum up to 32 channels)

With the MPL Peristaltic Pump line, you can deliver liquids from 0.6 µl to 22 ml/min per channel. A choice of either 4-, 8-, 12- or 16-channel models is available. The pumphead features a planetary gear drive for precise smooth flow and long tube life. The standard versions can be further expanded with an extension pump head to accommodate up to 32 channels. Select from either Manual or Manual/Analog pump versions. All functions are easily accessed using the membrane keypad.

Features

The drive features instant starting and stopping for precision fluid delivery and a time saving priming key for rapidly filling the tubes without altering the set speed of the pump. The MPL also has a low speed standby mode (0.1 RPM) to keep tubing lines open, valuable feature when working with viscous substances. The 'Auto-restart' feature allows the MPL to recover automatically from a power failure reducing setup time and the risk of inaccurately setting the pump speed. The pumphead speed is variable from 0.5 to 90 RPM, which is clearly displayed on a large LED readout for easy confirmation.

External Control

The Manual/Analog version can be controlled using an analog signal. This permits remote control of the pump when an automated experiment, such as integrating several pieces of equipment, is desired. For example, using the pump in conjunction with a pH or other controller to control fluid delivery to a reaction vessel.

For Multi-Channel Tubing Sets, see page A67.

A 25 pin D-sub connector provides access to the external control features of the Manual/Analog pump. Through this connector the user can control pump speed and direction as well as perform start and stop functions. Pump speed can be regulated using either an external voltage (0 to 30 V) or current (0 to 30 mA) source. Additionally, pump operation and speed can be monitored through the 25 pin connector.

The outer casing of the MPL has a sanitary chemical and knock-resistant finish providing superior durability. All MPL pumps accept a wide range of manifold tubing, see page A67.

Conversion of pump speed (RPMs) to Flow Rate:

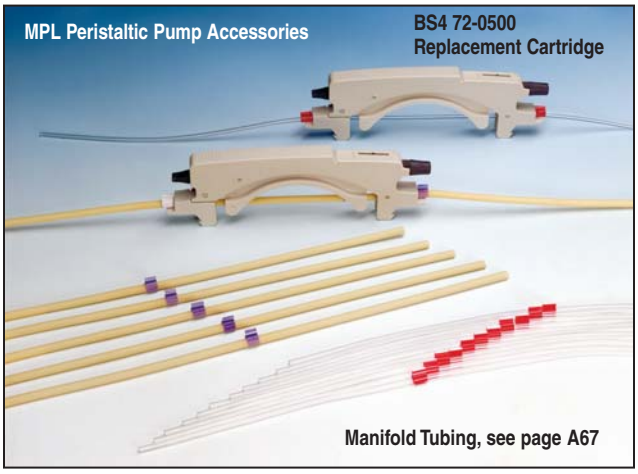
Target RPM = Max RPM x (Target Flow Rate/Max Flow Rate)
Max. flow rate is a function of the tube internal diameter.

Specifications

Speed Range	0.5 to 90 RPM
Voltage	110 to 120/220 to 240 VAC, 50/60 Hz (switchable)
Standards	IEC335-1, EN60529 (IP31), CE

MPL Multi-Channel Peristaltic Pump

Manual	Manual/ Analog	Channels	Dimensions, HxWxD	Weight
BS4 72-0501 $	**BS4 72-0502**	4-Channel	15.5 x 14.7 x 29 cm (6.13 x 5.75 x 11.5 in)	6.3 kg (13.8 lb)
BS4 72-0503 $	–	8-Channel	15.5 x 14.7 x 30 cm (6.13 x 5.75 x 13 in)	7.1 kg (15.6 lb)
BS4 72-0505 $	**BS4 72-0506**	12-Channel	15.5 x 14.7 x 38 cm (6.13 x 5.75 x 15 in)	7.9 kg (17.3 lb)
BS4 72-0507 $	**BS4 72-0508**	16-Channel	15.5 x 14.7 x 43 cm (6.13 x 5.75 x 17 in)	8.8 kg (19.3 lb)



Catalog No.	$	Product
BS4 72-0509		12-Channel Extension Head
BS4 72-0510		16-Channel Extension Head
BS4 72-0500		MPL Replacement Cartridge

Manifold Tubing for TPM & MPL Pumps

Manifold tubing sets for the TPM, see page A64 and MPL, see page A66, pumps are color coded tubing segments. Tubing segments are specific for the pumps indicated in the tables. Each segment must be connected with your process tubing using either tube to tube barbed connectors, see page A88. For a complete selection of tubing please see pages A78 to A87.

Manifold Tubing for Multi-Channel TPM Pumps, see page A64

Tube Bore mm (in)	Color Code	Max Flow Rate[1] (ml/min) 4-Roller	8-Roller	Silicone	Marprene	PVC	Connector[2] Size Gauge/Barb Size
0.13 mm (0.005 in)	Orange/Black	0.090	0.090	–	–	BS4 72-0653	32 g
0.19 mm (0.007 in)	Orange/Red	0.300	0.280	–	–	BS4 72-0654	31 g
0.25 mm (0.010 in)	Orange/Blue	0.520	0.470	–	BS4 72-0621	BS4 72-0655	28 g
0.38 mm (0.015 in)	Orange/Green	0.920	0.830	–	BS4 72-0622	BS4 72-0656	25 g
0.50 mm (0.020 in)	Orange/Yellow	1.70	1.40	–	BS4 72-0623	BS4 72-0657	23 g
0.63 mm (0.025 in)	Orange/White	3.10	2.60	BS4 72-0638	BS4 72-0624	BS4 72-0658	22 g
0.76 mm (0.030 in)	Black/Black	4.60	3.90	BS4 72-0639	BS4 72-0625	BS4 72-0659	20 g
0.88 mm (0.035 in)	Orange/Orange	6.40	5.30	BS4 72-0640	BS4 72-0626	BS4 72-0660	19 g
1.02 mm (0.040 in)	White/White	8.10	6.60	BS4 72-0641	BS4 72-0627	BS4 72-0661	18 g
1.14 mm (0.045 in)	Red/Red	9.90	8.80	BS4 72-0642	BS4 72-0628	BS4 72-0662	1/16 inch
1.29 mm (0.050 in)	Gray/Gray	13.0	10.0	BS4 72-0643	BS4 72-0629	BS4 72-0663	1/16 inch
1.42 mm (0.055 in)	Yellow/Yellow	17.0	12.0	BS4 72-0644	BS4 72-0630	BS4 72-0664	1/16 inch
1.47 mm (0.058 in)	Translucent	18.0	13.0	BS4 72-0645	–	–	1/16 inch
1.52 mm (0.060 in)	Yellow/Blue	19.0	14.0	BS4 72-0646	BS4 72-0631	BS4 72-0665	1/16 inch
1.65 mm (0.065 in)	Blue/Blue	22.0	17.0	BS4 72-0647	BS4 72-0632	BS4 72-0666	1/16 inch
1.85 mm (0.070 in)	Green/Green	28.0	20.0	BS4 72-0648	BS4 72-0633	BS4 72-0667	3/32 inch
2.05 mm (0.080 in)	Purple/Purple	33.0	24.0	BS4 72-0649	BS4 72-0634	BS4 72-0668	3/32 inch
2.38 mm (0.095 in)	Purple/Black	40.0	29.0	BS4 72-0650	BS4 72-0635	BS4 72-0669	3/32 inch
2.54 mm (0.100 in)	Purple/Orange	47.0	33.0	BS4 72-0651	BS4 72-0636	BS4 72-0670	1/8 inch
2.79 mm (0.110 in)	Purple/White	53.0	36.0	BS4 72-0652	BS4 72-0637	BS4 72-0671	1/8 inch
$							

[1] *Minimum flow rates are 5% of listed value, maximum speed rating: 110 rpm.*
[2] *Size of hypodermic tubing (g, gauge) or barbed connector (in). Connection with tubing segment requires hypodermic tubing or barbed connector, see pages A88 to A91.*

Manifold Tubing for MPL Pumps, see page A66

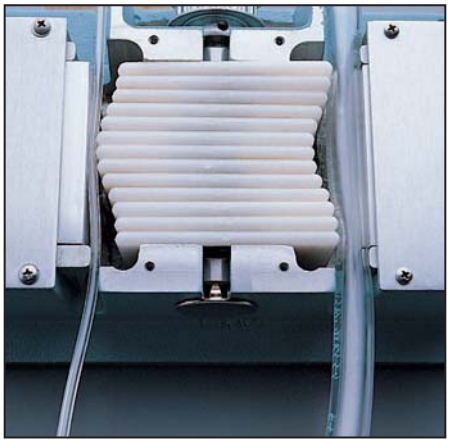
Tube Bore mm (in)	Color Code	Flow Rate (ml/min)	Silicone	Marprene	PVC	Solvent Resistant	Acid Resistant	Connector[2] Size Gauge/Barb Size
0.13 (0.005)	Orange/Black	0.0006 to 0.099	–	–	BS4 72-0543	BS4 72-0562	–	32 g
0.19 (0.007)	Orange/Red	0.0009 to 0.15	–	–	BS4 72-0544	BS4 72-0563	–	31 g
0.25 (0.010)	Orange/Blue	0.0013 to 0.23	–	BS4 72-0526	BS4 72-0545	BS4 72-0564	–	28 g
0.38 (0.015)	Orange/Green	0.0036 to 0.65	–	BS4 72-0527	BS4 72-0546	BS4 72-0565	–	25 g
0.50 (0.020)	Orange/Yellow	0.0056 to 1.01	–	BS4 72-0528	BS4 72-0547	BS4 72-0566	BS4 72-0581	23 g
0.63 (0.025)	Orange/White	0.0083 to 1.49	BS4 72-0511	BS4 72-0529	BS4 72-0548	BS4 72-0567	BS4 72-0582	22 g
0.76 (0.030)	Black/Black	0.011 to 2.02	BS4 72-0512	BS4 72-0530	BS4 72-0549	BS4 72-0568	BS4 72-0583	20 g
0.88 (0.035)	Orange/Orange	0.016 to 2.92	BS4 72-0513	BS4 72-0531	BS4 72-0550	BS4 72-0569	BS4 72-0584	19 g
1.02 (0.040)	White/White	0.021 to 3.76	BS4 72-0514	BS4 72-0532	BS4 72-0551	BS4 72-0570	BS4 72-0585	18 g
1.14 (0.045)	Red/Red	0.026 to 4.68	BS4 72-0515	BS4 72-0533	BS4 72-0552	BS4 72-0571	BS4 72-0586	1/16 inch
1.29 (0.050)	Gray/Gray	0.033 to 5.94	BS4 72-0516	BS4 72-0534	BS4 72-0553	BS4 72-0572	BS4 72-0587	1/16 inch
1.42 (0.055)	Yellow/Yellow	0.040 to 7.20	BS4 72-0517	BS4 72-0535	BS4 72-0554	BS4 72-0573	BS4 72-0588	1/16 inch
1.47 (0.058)	Translucent	0.0415 to 7.44	BS4 72-0518	–	–	–	–	1/16 inch
1.52 (0.060)	Yellow/Blue	0.043 to 7.69	BS4 72-0519	BS4 72-0536	BS4 72-0555	BS4 72-0574	BS4 72-0589	1/16 inch
1.65 (0.065)	Blue/Blue	0.051 to 9.12	BS4 72-0520	BS4 72-0537	BS4 72-0556	BS4 72-0575	BS4 72-0590	1/16 inch
1.85 (0.070)	Green/Green	0.063 to 11.3	BS4 72-0521	BS4 72-0538	BS4 72-0557	BS4 72-0576	BS4 72-0591	3/32 inch
2.05 (0.080)	Purple/Purple	0.076 to 13.8	BS4 72-0522	BS4 72-0539	BS4 72-0558	BS4 72-0577	BS4 72-0592	3/32 inch
2.29 (0.095)	Purple/Black	0.092 to 16.5	BS4 72-0523	BS4 72-0540	BS4 72-0559	BS4 72-0578	BS4 72-0593	3/32 inch
2.54 (0.100)	Purple/Orange	0.110 to 19.3	BS4 72-0524	BS4 72-0541	BS4 72-0560	BS4 72-0579	BS4 72-0594	1/8 inch
2.79 (0.110)	Purple/White	0.120 to 22.0	BS4 72-0525	BS4 72-0542	BS4 72-0561	BS4 72-0580	BS4 72-0595	1/8 inch
$								

Harvard Mechanical Peristaltic Pumps

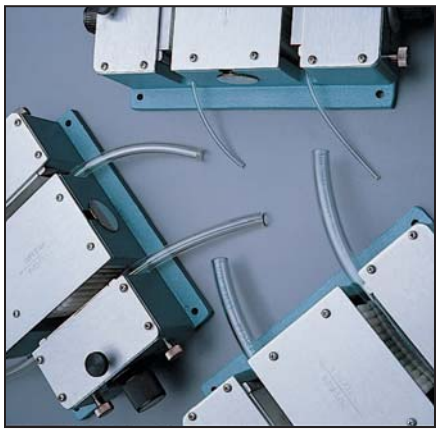
The bane of peristaltic pumps is the pulsation caused by the rotary head. This pulsation inevitably leads to reduced accuracy. The Harvard Mechanical Peristaltic Pumps are the only peristaltic pumps manufactured with a double linear pumping channel. This pumping channel eliminates pulsation and delivers accuracy.

This double linear channel has the additional advantage that extra tubing can be dropped straight in. There is no need to unwind the tubing from the head.

- *Speed range is infinitely variable to 50,000 to 1*
- *The two peristaltic sine waves are opposed at exactly 180°. Therefore, when the two tubes are coupled with a 'Y', a single smoothed minimum pulsatile delivery is achieved*
- *Three different flow rate models from which to choose*
- *Each of the three Pumps has a reversing switch on its control panel marked 'Infuse/Withdraw' to give the pump maximum flexibility*
- *The peristaltic pumping head is offered with three different power trains having 1/60th, 1/15th and 1/8th horse power motors*
- *For general laboratory use with a wide range of flow rates satisfying most laboratory uses*



Peristalsis is generated by thirteen nylon plates in wiping contact. These plates have Delrin® cam centers that are mounted on a heavy axle supported in ball bearings. The cam centers do not require lubrication because of the molybdenum disulphide in the Delrin®. The nylon plates provide a sinusoidal wave action 60.3 mm (2-3/8 in) long in each pumping channel, the two wave actions being 180° out of phase. By joining two identical tubes with a 'Y', a single smoothed minimum pulsatile flow is achieved.



Adjusting the pumping channel for any size tubing from micro to 12.7 mm (1/2 in) is a simple process. Lay the tubing in the channel, release the pressure plate by the top thumb screws, screw the pressure plate forward until it properly grips the tubing, and lock the pressure plate in place.

Note also that the pressure plate can be adjusted to bring the peristalsis fingers into mere wiping contact with the tubing to protect fragile material or, by fully compressing the tubing, heavy pressures can be provided to accommodate viscous materials.

Note further that the pressure plate can provide convenient temporary occlusion.

By using the same-sized tubing in each channel, exchange procedures can be carried out delivering and withdrawing exact amounts at the same time. Two tubes can be joined with a 'Y' to double the flow volume. Tubing of any size can be in each of the two channels. The screw-activated pressure plate instantly adjusts the size of the channel. Proportional delivery or withdrawal can be made. To add more tubing, merely pile it in the channel up to a height of 34.9 mm (1-3/8 in).

Harvard Mechanical Peristaltic Pumps


BS4 55-1788
Moderate
Volume
Mechanical
Peristaltic Pump

Harvard Model 1210 Moderate Volume Mechanical Laboratory Peristaltic Pump

- Delivers moderate quantities over a limited range of flow rates
- 1/15 HP motor

The pumping head is mounted on a strong steel case housing a 1/15 HP motor. There is no gear box but the motor speed is continuously variable from 10 to 200 rpm by means of a Silicon Controlled Rectifier motor control. A dial on the control panel is a pull and turn knob and is graduated from 10 to 200 RPM providing the choice of flow rates shown.

Supplied with a 3-wire, grounded power cord 2.7 m (9 ft) long, with a molded plug. A fuse holder, indicator light, 'On/Off' switch and 'Infuse/Withdraw' switch are on the front panel. For tubing for this pump, see pages A78 to A87.

Specifications

Model No.	1210	1210A
Power	115 VAC, 60 Hz	230 VAC, 50 Hz
Dimensions, H x W x D	178 x 381 x 265 mm (7 x 15 x 10-1/2 in)	
Weight	16.8 kg (37 lb)	

Catalog No.	$	Model	Product
BS4 55-1788		1210	Moderate Volume Mechanical Laboratory Peristaltic Pump, 110 VAC
BS4 55-1796		1210A	Moderate Volume Mechanical Laboratory Peristaltic Pump, 230 VAC

Harvard Model 1215 High Volume Mechanical Laboratory Peristaltic Pump

- Delivers quantities three times as great as the model 1210, over a limited range of flow rates
- 1/2 HP motor

This pump is exactly like the Model 1210 except that it has a 1/8 HP motor that is continuously variable from 30 to 600 rpm.

Supplied with a 3-wire, grounded power cord 2.7 m (9 ft) long, with a molded plug. A fuse holder, indicator light, 'On/Off' switch and 'Infuse/Withdraw' switch are on the front panel. For tubing for this pump, see pages A78 to A87.

Specifications

Model No.	1215	1215A
Power	115 VAC, 60 Hz	230 VAC, 50 Hz
Dimensions, H x W x D	178 x 381 x 267 mm (7 x 15 x 10-1/2 in)	
Weight	22 kg (48 lb)	

Catalog No.	$	Model	Product
BS4 55-1804		1215	Harvard High Volume Mechanical Laboratory Peristaltic Pump
BS4 55-1812		1215A	Harvard High Volume Mechanical Laboratory Peristaltic Pump

Flow Rates for the General Purpose Mechanical Peristaltic Pumps

	Model 1210 Flow Rate		Model 1215 Flow Rate	
Tubing ID	Minimum	Maximum	Minimum	Maximum
1/16 in	1.2 ml/min	20 ml/min	3.3 ml/min	70 ml/min
1/8 in	3.5 ml/min	70 ml/min	10.5 ml/min	210 ml/min
3/16 in	6.5 ml/min	130 ml/min	18.5 ml/min	390 ml/min
1/4 in	10 ml/min	200 ml/min	310 ml/min	600 ml/min
5/16 in	14 ml/min	280 ml/min	42 ml/min	840 ml/min
3/8 in	19 ml/min	380 ml/min	57 ml/min	1140 ml/min

For Tubing, see pages A78 to A87.

For Tubing Connectors and Kits, see pages A88 to A91.

Harvard Apparatus Stainless Steel Syringes

High Pressure Stainless Steel Syringes

- 1500 psi peak pressure
- Fits most Harvard pumps
- Electron beam welded
- Fully autoclavable
- 1/16 inch SWAGELOK® fitting for low dead volume

Harvard Apparatus now offers a completely new line of Stainless Steel Syringes intended for high pressure applications with good resistance to most aggressive liquids. Wetted parts are #316 stainless steel or Viton. Syringes are available in 20, 50, 100 and 200 ml sizes with removable replaceable tips. Genuine SWAGELOK® syringe to tube fittings are available in 1/16, 1/8 and 1/4 inch sizes. A luer lock end fitting is also available. All tips are interchangeable with all syringes (20 to 200 ml) in the series.

Both syringe barrel end plungers are #316 stainless steel. A Viton O-ring seal between top and end of the barrel insures against leakage. Syringes are guaranteed to be leak free for pressures up to 700 psi.

All syringes are supplied with inside diameter dimensions for use with Harvard microprocessor controlled pumps and rate charts for use with older 'classic' pumps. Replacement Viton O-Rings are available, as are the more chemically resistant Chemraz® O-Rings.

High Pressure 8 ml Stainless Steel Syringe

This syringe has been designed to utilize the high forces available in our syringe pumps to produce pressures up to 1500 psi. The syringe is constructed entirely of #316 stainless steel with two Chemraz® O-Ring seals and two Teflon O-Ring seals. Select from either a 1/16 inch or 1/8 inch SWAGELOK® end.

When this syringe is used in the BS4 70-2200 or BS4 70-2201 PHD 4400 Hpsi, see page A18, pressures in excess of 1500 psi are consistently achieved for chromatography and process control applications.

Specifications

Volume	8 ml
Dimensions:	
Overall Length of Barrel	16.5 cm (6-1/2 in)
Plunger Excursion	11.4 cm (4-1/2 in)
OD	1.6 cm (5/8 in)
ID	0.95 cm (3/8 in)
Maximum Test Pressure	4000 p.s.i
Working Pressure	1500 p.s.i

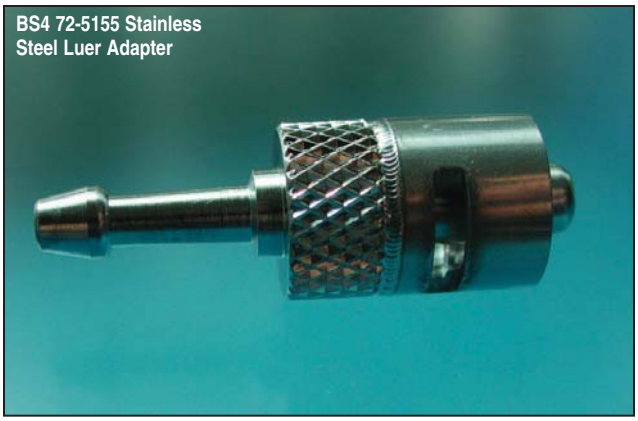
Catalog No.	$	Product
BS4 70-2267		High Pressure 8 ml Stainless Steel Syringe with 1/16 inch SWAGELOK®
BS4 70-2268		High Pressure 8 ml Stainless Steel Syringe with 1/8 inch SWAGELOK®
Replacement Parts		
BS4 5013-089		Chemraz® O-Ring 20 ml
BS4 5013-090		Chemraz® O-Ring 50 ml
BS4 5013-091		Chemraz® O-Ring 100 ml
BS4 5013-092		Chemraz® O-Ring 200 ml
BS4 5013-087		Chemraz® Tip Seal O-Ring All Sizes
BS4 72-2472		Replacement Viton O-Ring 20 ml, pkg. of 10
BS4 72-2473		Replacement Viton O-Ring 50 ml, pkg. of 10
BS4 72-2474		Replacement Viton O-Ring 100 ml, pkg. of 10
BS4 72-2475		Replacement Viton O-Ring 200 ml, pkg. of 10
BS4 72-2616		Replacement Viton Tip Seal O-Ring, All Sizes, pkg. of 20
BS4 72-2617		Stainless Steel Plunger Button to Adapt Syringe for use with PHD 22/2000 Hpsi, see page A16 (required for 50 and 100 ml syringes only)

High Pressure Stainless Steel Syringes

	With SWAGELOK®						With Luer Lock	
Syringe Size	Diameter 1/16 inch	$	1/8 inch	$	1/4 inch	$		$
20 ml	BS4 70-2251		BS4 70-2252		BS4 70-2253		BS4 70-2254	
50 ml	BS4 70-2255		BS4 70-2256		BS4 70-2257		BS4 70-2258	
100 ml	BS4 70-2259		BS4 70-2260		BS4 70-2261		BS4 70-2262	
200 ml	BS4 70-2263		BS4 70-2264		BS4 70-2265		BS4 70-2266	
Replacement Tips, Furnished with Sealing O-Ring								
	BS4 70-2247		BS4 70-2248		BS4 70-2249		BS4 70-2250	

For PEEK™ Adaptors, see page A71.

Adaptors


BS4 72-5155 Stainless Steel Luer Adapter

Precision 316 Stainless Steel Luer Adaptors

- Made of rugged 316 stainless steel
- Final assembly water tested at 45 psi

These precision 316 stainless Luer adaptors are ideal for connections that are exposed to harsh chemicals environments. These 316 adaptors are precision manufactured to meet ISO 594 specifications and are offered in a variety of styles to satisfy many applications. Each one is uniquely designed to facilitate easy cleaning and maintenance. They are supplied individually.

Catalog No.	$	Product
BS4 72-5155		Luer Type 316 Stainless Steel Connector Hose End 1/16"- 3/32" ID Tubing to Male Luer Lock
BS4 72-5156		Luer Type 316 Stainless Steel Connector Hose End 1/8"- 3/16" ID Tubing to Male Luer Lock
BS4 72-5157		Luer Type 316 Stainless Steel Connector Hose End 1/4"- 5/16" ID Tubing to Male Luer Lock
BS4 72-5158		Luer Type 316 Stainless Steel Connector Hose End 1/16"- 3/32" ID Tubing to Female Luer
BS4 72-5159		Luer Type 316 Stainless Steel Connector Hose End 1/8"- 3/16" ID Tubing to Female Luer
BS4 72-5160		Luer Type 316 Stainless Steel Connector Hose End 3/16 - 1/4" ID Tubing to Female Luer
BS4 72-5161		Luer Type 316 Stainless Steel Adapters Male Luer Lock - Closed End
BS4 72-5162		Luer Type 316 Stainless Steel Adapters Female Luer - Male Luer Lock
BS4 72-5163		Luer Type 316 Stainless Steel Adapters Male Luer - Closed End
BS4 72-5164		Luer Type 316 Stainless Steel Male Luer Lock-10-32 Standard Thread
BS4 72-5165		Luer Type 316 Stainless Steel Male Luer Lock-1/4"-28 Standard Thread
BS4 72-5166		Luer Type 316 Stainless Steel Female Luer-10-32 Standard Thread

PEEK™ Luer Adaptors

- Made of inert PEEK™
- Quick, leak-proof connection
- Economical

Made of inert PEEK™ and designed for quick, leak-proof connections. These adaptors are economical and provide for flexibility of connection for a variety of thread configurations. These adaptors are available in a variety of configurations. Select the adaptor based on your requirements.

Catalog No.	$	Product
BS4 72-5140		Luer PEEK™ 1/4"-28 Internal Thread to Male Luer Lock
BS4 72-5141		Luer PEEK™ 1/4"-28 Internal Thread to Female Luer
BS4 72-5142		Luer PEEK™ 1/4"-28 Thread to Male Luer Lock
BS4 72-5143		Luer PEEK™ 1/4"-28 Thread to Female Luer
BS4 72-5144		Luer PEEK™ 10-32 Internal Thread to Male Luer Lock
BS4 72-5145		Luer PEEK™ 10-32 Internal Thread to Female Luer
BS4 72-5146		Luer PEEK™ 10-32 Thread to Male Luer Lock
BS4 72-5147		Luer PEEK™ 10-32 Thread to Female Luer
BS4 72-5148		Luer PEEK™ M6 Metric Internal Thread to Male Luer Lock
BS4 72-5149		Luer PEEK™ M6 Metric Internal Thread to Female Luer
BS4 72-5150		Luer PEEK™ M6 Metric Thread to Male Luer Lock
BS4 72-5151		Luer PEEK™ M6 Metric Thread to Female Luer

Micro-Mate® Adaptors

- Made of rugged 316 stainless steel
- Final assembly water tested at 45 psi

316 stainless Micro-Mate® female Luers adaptors can handle harsh chemical environments and feature a special thread designed to reduce the stripping of threads which occurs when metal Luers are mated with plastic Male Luer Lock adaptors. Micro-Mate® Luers meet ISO 594 specifications and facilitate easy cleaning and maintenance. These adaptors are supplied individually.

Catalog No.	$	Product
BS4 72-5152		Micro-Mate® Luer Type 316 Stainless Steel Adapter Female Luer to Closed End Electropolished
BS4 72-5153		Micro-Mate® Luer Type 316 Stainless Steel Adapter Female Luer to Male Luer Electropolished
BS4 72-5154		Micro-Mate® Luer Type 316 Stainless Steel Female Luer to 1/4"-28 Standard Thread Electropolished

Hamilton™ Glass Syringes

Harvard Apparatus now offers a complete line of syringes in a variety of styles and sizes. We have introduced a broad selection of Hamilton™ microliter and specialty syringes along with an extensive selection of Kendall Monoject® plastic syringes. Our syringe selection continues to grow. Please visit our website or contact our customer service department for the latest offerings.

Hamilton syringes are considered the industry standard for precision fluid delivery. Harvard Apparatus offers a broad selection of these precision syringes which, when combined with our syringe pumps, offer fluid delivery with unparalleled accuracy and precision. A variety of syringe terminations are available to interface with virtually any system or experimental protocol. Hamilton microliter syringe options include: reinforced syringe plungers, reinforced syringe barrels, and GASTIGHT® syringes with syringe volumes from 0.5 µl to 100 ml (for standard glass syringes). Many syringes have replaceable plungers and barrels. Several accessories are also available for their microliter syringes including syringe guides for added plunger stability and cleaning wires and solution to maximize the life of your syringe.

- Sizes from 0.5 ml to 2000 ml syringes available
- Nine different styles of Hamilton™ syringes from which to choose
- 5 different terminations
- Standard and instrument plunger styles available
- Standard and GASTIGHT® syringes
- Specialty syringes and accessories

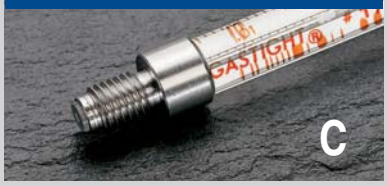
Syringe Terminations

Syringes end in one of the following configurations:

LT - Luer Tip, standard tapered male luer

RN - Removable Needle, proprietary needle which seats precisely to zero graduation mark of syringe

C - Chem fitting



KH - 7000 Series syringes only, removable needle similar to RN

TLL - Teflon® Luer Lock, male luer taper with nickel plated brass hub lock

Point Styles
RN and KH needles are available in two different point styles. Point style 2 is a non-coring Huber-like bevel. Point style 3 is blunt.

Point Style 2

Point Style 3

Syringe Plungers

Most are fine wire with button plungers. Some are interchangeable/replaceable

Standard Plunger

Instrument Plunger
CX - Chem with stop
TLLX - Teflon Luer Lock with stop

X Suffix (e.g. TLLX & CX)
Indicates syringe with Instrument stop, recommended for use with syringe pumps or drives for microliter syringes to prevent damage.

Special Needle Sizes

An "s" following the needle gauge indicates a special size, see below.

Special Needle Sizes (mm)			
Gauge	OD	ID	Wall Thickness
22s	0.72	0.15	0.28
25s	0.51	0.15	0.18
26s	0.47	0.13	0.18

All other gauges listed are standard dimensions, see page B17 for needle size chart. Custom needle tips, gauges and lengths are available, call for more information.

Hamilton™ Glass Syringes - Call for Pricing

800 Series Syringes

Syringe sizes from 5 to 250 µl available. Reinforced plunger: Replaceable plunger barrel assembly.

800 Series Syringes

Catalog No.	Vol.	Ter.	Point Style	Ga.*	Replacement Needle (pkg. of 3)	Plunger Barrel Assembly
BS4 72-1724	5 µl	RN	2	26s	BS4 72-1881	BS4 72-1730
BS4 72-1725	10 µl	RN	2	26s	BS4 72-1881	BS4 72-1731
BS4 72-1726	25 µl	RN	2	22s	BS4 72-1882	BS4 72-1732
BS4 72-1727	50 µl	RN	2	22s	BS4 72-1882	BS4 72-1733
BS4 72-1728	100 µl	RN	2	22s	BS4 72-1882	BS4 72-1734
BS4 72-1729	250 µl	RN	2	22s	BS4 72-1893	BS4 72-1735

7000 Series Modified Microliter™ Syringes

Ultra low volume syringes: 0.5 to 5 µl. No Dead Volume – sample contained entirely in needle. Replaceable syringe barrels and parts. The KH repair kit includes KH needle, KH ferrule, plunger wire and instruction sheet.

7000 Series Modified Microliter™ Syringes

Catalog No.	Volume	Terminus	Point Style	Gauge*	KH Repair Kit
BS4 72-1736	0.5 µl	KH	2	25	BS4 72-1749
BS4 72-1737	1 µl	KH	2	25s	BS4 72-1750
BS4 72-1738	1 µl	KH	2	22s	BS4 72-1751
BS4 72-1739	2 µl	KH	2	25	BS4 72-1752
BS4 72-1740	2 µl	KH	2	23	BS4 72-1753
BS4 72-1741	5 µl	KH	2	24	BS4 72-1754
BS4 72-1742	0.5 µl	KH	3	32	BS4 72-1755
BS4 72-1743	0.5 µl	KH	3	25	BS4 72-1756
BS4 72-1744	1 µl	KH	3	25s	BS4 72-1757
BS4 72-1745	1 µl	KH	3	22s	BS4 72-1758
BS4 72-1746	2 µl	KH	3	25	BS4 72-1759
BS4 72-1747	2 µl	KH	3	23	BS4 72-1760
BS4 72-1748	5 µl	KH	3	24	BS4 72-1761

** Note: An 's' after the gauge size refers to a special needle size, see chart on page A72.*

1700 Series GASTIGHT® Syringes

Teflon® PTFE tipped plungers. Replaceable plungers and needles. Sizes: 10 to 500 µl. Replacement needles are sold in packages of 3.

1700 Series GASTIGHT® Syringes

Catalog No.	Vol.	Ter.	Point Style	Ga.*	Replacement Parts Needle	Plunger	Barrel
BS4 72-1762	10 µl	LT	–	–	–	BS4 72-1785	–
BS4 72-1763	25 µl	LT	–	–	–	BS4 72-1786	–
BS4 72-1764	50 µl	LT	–	–	–	BS4 72-1787	–
BS4 72-1765	100 µl	LT	–	–	–	BS4 72-1788	–
BS4 72-1766	250 µl	LT	–	–	–	BS4 72-1789	–
BS4 72-1767	500 µl	LT	–	–	–	BS4 72-1790	–
BS4 72-1824	5 µl	RN	3	32	BS4 72-5743	Call	–
BS4 72-1825	10 µl	RN	3	32	BS4 72-5743	BS4 72-1785	–
BS4 72-1768	10 µl	RN	2	26s	BS4 72-5744	BS4 72-1785	–
BS4 72-1769	25 µl	RN	2	22s	BS4 72-5745	BS4 72-1786	–
BS4 72-1770	50 µl	RN	2	22s	BS4 72-5745	BS4 72-1792	–
BS4 72-1771	100 µl	RN	2	22s	BS4 72-5745	BS4 72-1793	–
BS4 72-1772	250 µl	RN	2	22s	BS4 72-5746	BS4 72-1794	–
BS4 72-1773	500 µl	RN	2	22	BS4 72-5747	BS4 72-1795	–
BS4 72-1774	10 µl	RN	3	22s	BS4 72-5748	BS4 72-1785	–
BS4 72-1775	25 µl	RN	3	22s	BS4 72-5751	BS4 72-1786	–
BS4 72-1776	50 µl	RN	3	22s	BS4 72-5751	BS4 72-1792	–
BS4 72-1777	100 µl	RN	3	22s	BS4 72-5751	BS4 72-1793	–
BS4 72-1778	250 µl	RN	3	22s	BS4 72-5752	BS4 72-1794	–
BS4 72-1779	500 µl	RN	3	22	BS4 72-5752	BS4 72-1795	–
BS4 72-1781	50 µl	TLL	–	–	–	BS4 72-1792	BS4 72-1797
BS4 72-1782	100 µl	TLL	–	–	–	BS4 72-1793	BS4 72-1798
BS4 72-1783	250 µl	TLL	–	–	–	BS4 72-1794	BS4 72-1799
BS4 72-1784	500 µl	TLL	–	–	–	BS4 72-1795	BS4 72-1800
BS4 72-1780	25 µl	TLLX	–	–	–	BS4 72-1791	BS4 72-1796
BS4 72-1901	50 µl	TLLX	–	–	–	BS4 72-1808	BS4 72-1897
BS4 72-1902	100 µl	TLLX	–	–	–	BS4 72-1809	BS4 72-1798
BS4 72-1903	250 µl	TLLX	–	–	–	BS4 72-1810	BS4 72-1799
BS4 72-1904	500 µl	TLLX	–	–	–	BS4 72-1811	BS4 72-1800
BS4 72-1801	10 µl	CX	¼-28	–	–	BS4 72-1807	BS4 72-1905
BS4 72-1802	25 µl	CX	¼-28	–	–	BS4 72-1791	BS4 72-1906
BS4 72-1803	50 µl	CX	¼-28	–	–	BS4 72-1808	BS4 72-1907
BS4 72-1804	100 µl	CX	¼-28	–	–	BS4 72-1809	BS4 72-1908
BS4 72-1805	250 µl	CX	¼-28	–	–	BS4 72-1810	BS4 72-1909
BS4 72-1806	500 µl	CX	¼-28	–	–	BS4 72-1811	BS4 72-1910

Hamilton™ Glass Syringes - Call for Pricing

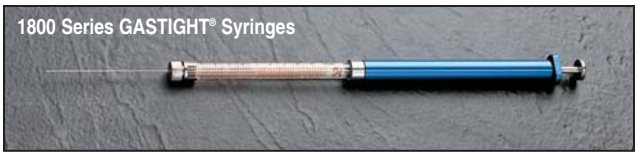
700 Series Syringes

Economical Microliter Syringes. Barrels and plungers are NOT interchangeable or replaceable. Syringe sizes from 5 to 500 µl available.

700 Series Syringes

Catalog No.	Vol.	Ter.	Point Style	Gauge*	Replacement Needle (pkg. of 3)
BS4 72-1717	5 µl	RN	2	26s	BS4 72-1881
BS4 72-1822	5 µl	RN	3	32	BS4 72-1887
BS4 72-1718	10 µl	RN	2	26s	BS4 72-1881
BS4 72-1823	10 µl	RN	3	32	BS4 72-1887
BS4 72-1719	25 µl	RN	2	22s	BS4 72-1882
BS4 72-1720	50 µl	RN	2	22s	BS4 72-1882
BS4 72-1721	100 µl	RN	2	22s	BS4 72-1882
BS4 72-1722	250 µl	RN	2	22s	BS4 72-1893
BS4 72-1723	500 µl	RN	2	22	BS4 72-1883
BS4 72-1711	10 µl	LT	–	–	–
BS4 72-1712	25 µl	LT	–	–	–
BS4 72-1713	50 µl	LT	–	–	–
BS4 72-1714	100 µl	LT	–	–	–
BS4 72-1715	250 µl	LT	–	–	–
BS4 72-1716	500 µl	LT	–	–	–

** Note: An "s" after the gauge size refers to a special needle size, see chart on page A72.*



1800 Series GASTIGHT® Syringes

Reinforced, Teflon® PTFE tipped plungers. Replaceable plungers assembly and needle. Syringe sizes from 10 to 250 µl available.

1800 Series GASTIGHT® Syringes

Catalog No.	Vol.	Terminus	Point Style	Gauge*	Replacement Needle (pkg. of 3)
BS4 72-1812	10 µl	RN	2	26s	BS4 72-1881
BS4 72-1813	25 µl	RN	2	22s	BS4 72-1882
BS4 72-1814	50 µl	RN	2	22s	BS4 72-1882
BS4 72-1815	100 µl	RN	2	22s	BS4 72-1882
BS4 72-1816	250 µl	RN	2	22s	BS4 72-1893

** Note: An "s" after the gauge size refers to a special needle size, see chart on page A72.*

Did you know ? **Harvard Apparatus now sells products for molecular biology. See Section N for complete details.**

1000 Series GASTIGHT® Syringes

Teflon® PTFE tipped plungers. Replaceable plungers and needles sizes: 1 to 100 ml, Terminus: LT, TLL, RN, C

1000 Series GASTIGHT® Syringes

Catalog No.	Vol.	Ter.	Point Style	Ga.	Replacement Parts: Needle (pkg. of 6)	Replacement Parts: Plunger Assembly
BS4 72-1826	1 ml	LT	–	–	–	BS4 72-1894
BS4 72-1827	1.25 ml	LT	–	–	–	BS4 72-1895
BS4 72-1828	2.5 ml	LT	–	–	–	BS4 72-1896
BS4 72-1829	5 ml	LT	–	–	–	BS4 72-1897
BS4 72-1830	10 ml	LT	–	–	–	BS4 72-1898
BS4 72-1831	1 ml	TLL	–	–	–	BS4 72-1894
BS4 72-1832	2.5 ml	TLL	–	–	–	BS4 72-1896
BS4 72-1833	5 ml	TLL	–	–	–	BS4 72-1897
BS4 72-1834	10 ml	TLL	–	–	–	BS4 72-1898
BS4 72-1835	25 ml	TLL	–	–	–	BS4 72-1899
BS4 72-1836	50 ml	TLL	–	–	–	BS4 72-1900
BS4 72-1837	100 ml	TLL	–	–	–	–
BS4 72-1838	1 ml	RN	2	22	BS4 72-7139	BS4 72-1894
BS4 72-1839	2.5 ml	RN	2	22	BS4 72-7139	BS4 72-1896
BS4 72-1840	5 ml	RN	2	22	BS4 72-7139	BS4 72-1897
BS4 72-1841	10 ml	RN	2	22	BS4 72-7139	BS4 72-1898
BS4 72-1842	1 ml	C	–	1/4-28	–	BS4 72-1894
BS4 72-1843	2.5 ml	C	–	1/4-28	–	BS4 72-1896
BS4 72-1844	5 ml	C	–	1/4-28	–	BS4 72-1897
BS4 72-1845	10 ml	C	–	1/4-28	–	BS4 72-1898

Call for pricing

Constant Rate Syringes

Spring-driven plunger injects samples at a constant rate. Incremental volumes are selectable with mm precision. Volumes: 20, 50, 200 µl

Catalog No.	$	Product
BS4 72-1854		Constant Rate Syringe, 20 µl
BS4 72-1855		Constant Rate Syringe, 50 µl
BS4 72-1856		Constant Rate Syringe, 200 µl

Specialty Syringes and Accessories

Threaded Plunger Syringes

For applications requiring extremely precise plunger movement LT Terminus Volumes from 25 µl to 10 ml

Threaded Plunger Syringes				
Catalog No.	$	Volume	Terminus	Dispense Volume
BS4 72-1857		25 µl	LT	0.33 µl/revolution
BS4 72-1858		50 µl	LT	0.66 µl/revolution
BS4 72-1859		100 µl	LT	1.32 µl/revolution
BS4 72-1860		250 µl	LT	3.31 µl/revolution
BS4 72-1861		500 µl	LT	6.62 µl/revolution
BS4 72-1862		500 µl	LT	5.29 µl/revolution
BS4 72-1863		1 ml	LT	13.23 µl/revolution
BS4 72-1864		2.5 ml	LT	37.79 µl/revolution
BS4 72-1865		5 ml	LT	75.57 µl/revolution
BS4 72-1866		10 ml	LT	151.14 µl/revolution

Popper Multifit Glass Syringes

These are standard glass Syringes with Luer Lock tips. The barrels and plungers of the same-sized Syringes are interchangeable.

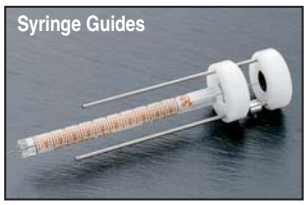
Popper Multifit Glass Syringes					
Catalog No.	$	Syringe Size	Catalog No.	$	Syringe Size
BS4 55-0913		2 cc	BS4 55-0947		20 cc
BS4 55-0921		5 cc	BS4 55-0954		30 cc
BS4 55-0939		10 cc	BS4 55-0962		50 cc

Becton-Dickinson Yale Glass Syringe with Robb Tip, 100 ml

The plunger and barrel of this glass Syringe are ground and mated for a tight fit. They are not interchangeable with other barrels or plungers. The parts are numbered for easy reassembly.

This Syringe dispenses large volumes in short time periods. Therefore, it has a Robb tip with a 12 gauge bore of 0.223 cm (0.088 in). Fitted with Luer lock tip. 100 ml size only.

Catalog No.	$	Product
BS4 55-1002		Becton-Dickinson Yale Glass Syringe with Robb Tip, 100 ml



Syringe Guides

Prevent syringe plunger from bending. For manual (hand held) operation only. Adjustable Stop.

Works with 700, 1700 and 7000 series syringes.

Syringe Guides					
			For Use with Syringe Series		
Catalog No.	$	Volume	700	1700	7000
BS4 72-1868		0.5 to 5 µl			•
BS4 72-1867		5 to 10 µl	•		
BS4 72-1867		5 to 10 µl		•	
BS4 72-1868		25 to 500 µl	•		
BS4 72-1868		25 to 500 µl		•	

Needle Cleaning Kit

Fine gauge tungsten wires used to clear plugged needles. Biodegradable cleaning solutions are used to remove residues from syringe needles and barrels. All cleaning wires are 7 inches long and are sold in a package of 10. Cleaning concentrate is sold separately.

Cleaning Wires			
Catalog No.	$	To Clean Needle Gauge	Wire Size OD
BS4 72-1873		23s, 26s, 31 to 33	0.0762 mm (0.00300 in)
BS4 72-1874		26s, 31 to 33	0.0889 mm (0.00350 in)
BS4 72-1875		22s, 25s, 28 to 30	0.1262 mm (0.00497 in)
BS4 72-1876		27	0.1674 mm (0.00659 in)
BS4 72-1877		24 to 26	0.2070 mm (0.00815 in)
BS4 72-1878		22, 23	0.3066 mm (0.01207 in)

Catalog No.	$	Product
BS4 72-1879		Cleaning Concentrate, 70 ml
BS4 72-1880		Cleaning Concentrate, 500 ml
BS4 72-1872		All Cleaning Wires and 70 ml of Cleaning Concentrate

Removable (RN) Adapters

Provides connection of Luer fittings to RN syringes ≥ 250 µl

Catalog No.	$	Product
BS4 72-1869		RN Hub to Female Luer
BS4 72-1870		RN Hub to Male Luer
BS4 72-1871		RN Hub to Male Luer Lock

Plastic Syringes

Super Syringes

For air sampling, preparing gas standards and calibration of pneumotachs and spirometers. Special Termination: Tracheal Adapter (accepts 5/8 inch ID tubing)

Super Syringe			
Catalog No.	$	Volume	Terminus
BS4 72-1846		500 ml	TLL
BS4 72-1847		1000 ml	TLL
BS4 72-1848		1500 ml	TLL
BS4 72-1849		2000 ml	TLL
BS4 72-1850		500 ml	Tracheal
BS4 72-1851		1000 ml	Tracheal

Hamilton™ Syringes

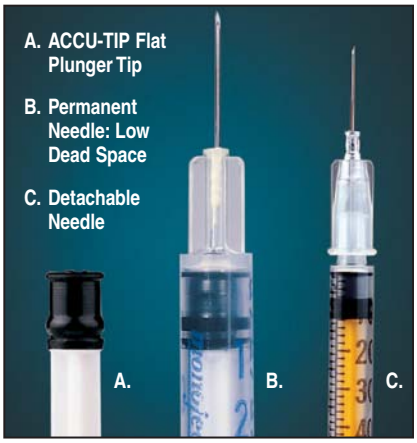
Some additional suggestions to assist you in selecting the best syringe for your application.

- *Reinforced Plunger – Select this style if your setup or application may cause the plunger to bend (Series 800 and 1800 syringes, see pages A73 and A74)*
- *Replaceable Barrel Syringes – Select this style if your setup or application may cause the barrel to break or bend (Series 800, 1000 and 1700 syringes, see pages A73 and A74)*
- *Removable Needles – Select syringes with LT or TLL termini along with either disposable or reusable needles. For our complete selection of Luer needles including sterile disposable, non-sterile and specialty needles, see pages B15 to B22.*
- *Chem Terminus – Select syringes with a C terminus if you require a threaded fitting for high pressure applications. See page A74 for threaded unions compressions fittings.*

Single Use Monoject® Plastic Syringes

- Syringe Volumes from 0.3 to 1 cc
- Rigid or blister packaging
- Permanent or detachable needle
- Accutip syringe plunger

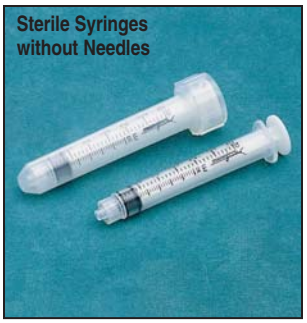
These syringes feature a new resin which provides greater clarity while still possessing all the same functional characteristics and biocompatibility requirements as traditional polypropylene syringes. They are packaged either Sterile or Non-Sterile. Rigid pack syringes feature a tamper-evident heat stake. There are five different syringe tip styles from which to choose. Please call for pricing.

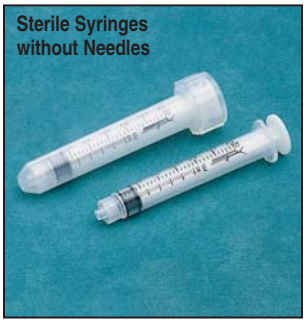


Single Use Monoject Plastic Syringes								
Vol.	Needle Gauge	Needle Length	Needle * Attachment	Pack Type	Safety Shield	Catalog No. Box of 100	Case of Syringes Qty.	Catalog No.
0.3 cc	29	0.5 in	P	Blister	–	BS4 72-2419	300	BS4 72-2437
0.3 cc	29	0.5 in	P	Rigid	Yes	BS4 72-2420	500	BS4 72-2438
0.5 cc	28	0.5 in	P	Rigid	–	BS4 72-2421	500	BS4 72-2439
0.5 cc	28	0.5 in	P	Blister	–	BS4 72-2422	300	BS4 72-2440
0.5 cc	29	0.5 in	P	Blister	–	BS4 72-2424	300	BS4 72-2442
0.5 cc	29	0.5 in	P	Rigid	Yes	BS4 72-2425	500	BS4 72-2443
1 cc	25	0.625 in	D	Rigid	–	BS4 72-2426	500	BS4 72-2444
1 cc	25	0.625 in	P	Rigid	–	BS4 72-2427	500	BS4 72-2445
1 cc	25	0.625 in	P	Rigid	Yes	–	500	BS4 72-2447
1 cc	26	0.375 in	D	Rigid	–	BS4 72-2429	500	BS4 72-2448
1 cc	27	0.5 in	D	Rigid	–	BS4 72-2430	500	BS4 72-2449
1 cc	28	0.5 in	P	Rigid	–	BS4 72-2432	500	BS4 72-2451
1 cc	28	0.5 in	P	Blister	–	BS4 72-2433	500	BS4 72-2452
1 cc	28	0.5 in	P	Rigid	Yes	–	500	BS4 72-2454
1 cc	29	0.5 in	P	Blister	–	BS4 72-2435	300	BS4 72-2455
1 cc	29	0.5 in	P	Rigid	Yes	BS4 72-2436	500	BS4 72-2456

**Note: P - Permanent; D - Detachable*

Plastic Syringes - Call for Pricing





Sterile Monoject® Syringes without Needles

Volume	Tip	Box of Syringes Qty.	Box of Syringes Catalog No.	Case of Syringes Qty.	Case of Syringes Catalog No.
1 ml	Luer (long barrel)	100	BS4 72-2359	500	BS4 72-2379
1 ml	Luer	100	BS4 72-2360	500	BS4 72-2380
3 ml	Luer	100	BS4 72-2361	1000	BS4 72-2381
6 ml	Luer	50	BS4 72-2362	500	BS4 72-2382
6 ml	Luer Lock	50	BS4 72-2363	500	BS4 72-2383
12 ml	Luer	80	BS4 72-2364	480	BS4 72-2384
12 ml	Luer Lock	80	BS4 72-2365	480	BS4 72-2385
12 ml	Eccentric Luer	80	BS4 72-2366	480	BS4 72-2386
20 ml	Luer	50	BS4 72-2367	300	BS4 72-2387
20 ml	Luer Lock	50	BS4 72-2368	300	BS4 72-2388
20 ml	Eccentric Luer	50	BS4 72-2369	300	BS4 72-2389
35 ml	Luer	30	BS4 72-2370	180	BS4 72-2390
35 ml	Luer Lock	30	BS4 72-2371	180	BS4 72-2391
35 ml	Eccentric Luer	30	BS4 72-2372	180	BS4 72-2392
35 ml	Catheter	30	BS4 72-2373	180	BS4 72-2393
60 ml	Luer	20	BS4 72-2374	100	BS4 72-2394
60 ml	Luer Lock	20	BS4 72-2375	100	BS4 72-2395
60 ml	Eccentric Luer	20	BS4 72-2376	100	BS4 72-2396
60 ml	Catheter	20	BS4 72-2377	100	BS4 72-2397
60 ml	Toomey	20	BS4 72-2378	100	BS4 72-2398
140 ml	Luer Lock	–	–	20	BS4 72-2399

Call for pricing

Sterile Monoject® Syringes without Needles

Volume	Tip	Box of Syringes Qty.	Box of Syringes Catalog No.	Case of Syringes Qty.	Case of Syringes Catalog No.
1 ml	Luer (long barrel)	100	BS4 72-2359	500	BS4 72-2379
1 ml	Luer	100	BS4 72-2360	500	BS4 72-2380
3 ml	Luer	100	BS4 72-2361	1000	BS4 72-2381
6 ml	Luer	50	BS4 72-2362	500	BS4 72-2382
6 ml	Luer Lock	50	BS4 72-2363	500	BS4 72-2383
12 ml	Luer	80	BS4 72-2364	480	BS4 72-2384
12 ml	Luer Lock	80	BS4 72-2365	480	BS4 72-2385
12 ml	Eccentric Luer	80	BS4 72-2366	480	BS4 72-2386
20 ml	Luer	50	BS4 72-2367	300	BS4 72-2387
20 ml	Luer Lock	50	BS4 72-2368	300	BS4 72-2388
20 ml	Eccentric Luer	50	BS4 72-2369	300	BS4 72-2389
35 ml	Luer	30	BS4 72-2370	180	BS4 72-2390
35 ml	Luer Lock	30	BS4 72-2371	180	BS4 72-2391
35 ml	Eccentric Luer	30	BS4 72-2372	180	BS4 72-2392
35 ml	Catheter	30	BS4 72-2373	180	BS4 72-2393
60 ml	Luer	20	BS4 72-2374	100	BS4 72-2394
60 ml	Luer Lock	20	BS4 72-2375	100	BS4 72-2395
60 ml	Eccentric Luer	20	BS4 72-2376	100	BS4 72-2396
60 ml	Catheter	20	BS4 72-2377	100	BS4 72-2397
60 ml	Toomey	20	BS4 72-2378	100	BS4 72-2398
140 ml	Luer Lock	–	–	20	BS4 72-2399

Non-Sterile Monoject® Syringes without Needles

Volume	Tip	Box of Syringes Qty.	Box of Syringes Catalog No.	Case of Syringes Qty.	Case of Syringes Catalog No.
3 ml	Luer	250	BS4 72-2400	1000	BS4 72-2408
6 ml	Luer	100	BS4 72-2401	500	BS4 72-2409
12 ml	Luer	100	BS4 72-2402	500	BS4 72-2410
12 ml	Eccentric Luer	100	BS4 72-2403	500	BS4 72-2411
20 ml	Luer	50	BS4 72-2404	250	BS4 72-2412
20 ml	Eccentric Luer	50	BS4 72-2405	250	BS4 72-2413
35 ml	Luer	25	BS4 72-2406	100	BS4 72-2414
60 ml	Luer	25	–	100	BS4 72-2415
140 ml	Luer	–	–	20	BS4 72-2416
140 ml	Luer Lock	–	–	20	BS4 72-2417
140 ml	Catheter	–	–	20	BS4 72-2418

Call for pricing

Non-Sterile Monoject® Syringes without Needles

Volume	Tip	Box of Syringes Qty.	Box of Syringes Catalog No.	Case of Syringes Qty.	Case of Syringes Catalog No.
3 ml	Luer	250	BS4 72-2400	1000	BS4 72-2408
6 ml	Luer	100	BS4 72-2401	500	BS4 72-2409
12 ml	Luer	100	BS4 72-2402	500	BS4 72-2410
12 ml	Eccentric Luer	100	BS4 72-2403	500	BS4 72-2411
20 ml	Luer	50	BS4 72-2404	250	BS4 72-2412
20 ml	Eccentric Luer	50	BS4 72-2405	250	BS4 72-2413
35 ml	Luer	25	BS4 72-2406	100	BS4 72-2414
60 ml	Luer	25	BS4 72-2407	100	BS4 72-2415
140 ml	Luer	–	–	20	BS4 72-2416
140 ml	Luer Lock	–	–	20	BS4 72-2417
140 ml	Catheter	–	–	20	BS4 72-2418

Laboratory Tubing & Connectors

Harvard Apparatus now offers an extensive selection of tubing and connectors for all of your laboratory application needs. We offer a wide range of tubing and connectors for virtually every bioscience application. Tubing is available in a variety of materials and dimensions. Sizes in addition to that which is presented here are listed on our Website or contact our sales staff for a complete list of available tubing. Tubing connectors with barbed or luer ends come in several different material types to suit a wide range of research applications. In addition, many valves and manifolds are now available to simplify tubing connections and flow control even in the most demanding experimental protocols. Tubing connector kits feature a selection of similarly sized connectors in one convenient container. All the individual kit components can be reordered. Visit our Website or contact our sales staff for reordering information.

Tygon® Long Flex Life Pump Tubing (LFL)

- Longest flex life of any clear Tygon® tubing
- Extremely low particulate spallation
- Broad chemical resistance
- Meets USP Class VI and FDA criteria

Specifically developed for bulk transfer applications, Tygon® Long Flex Life Tubing offers the longest peristaltic pump life of any clear Tygon® tubing formulation.

Crystal-clear Tygon® Long Flex Life Pump Tubing is formulated specifically for use in peristaltic pump applications. With its superior flex life characteristics, manufacturing processes can be simplified by reducing production downtime due to pump tubing failure.

The excellent wear properties of Tygon® Long Flex Life Pump Tubing also lead to a reduction of particulate spallation. This feature limits the risk of sensitive-fluid contamination critical to the pharmaceutical, cosmetic, food and beverage industries.

Non-aging characteristics and broad chemical resistance provide users with versatility in use for a wide variety of applications. Safe and non-toxic Tygon® Long Flex Life Pump Tubing can be produced in up to a 6 inch ID, making it the ideal choice in bulk transfer applications. Durometer hardness: Shore A, 56.*

Tygon LFL		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-0983		1.6	4.8	1/16	3/16	7.6	25
BS4 72-0984		3.2	6.4	1/8	1/4	7.6	25
BS4 72-0985		4.8	7.9	3/16	5/16	7.6	25
BS4 72-0986		6.4	9.5	1/4	3/8	7.6	25
BS4 72-0987		6.4	12.7	1/4	1/2	7.6	25
BS4 72-0988		7.9	11.1	5/16	7/16	7.6	25
BS4 72-0989		9.5	15.9	3/8	5/8	7.6	25
BS4 72-0990		12.7	19.1	1/2	3/4	7.6	25
BS4 72-0991		19.1	31.8	3/4	1 1/4	3.0	10
BS4 72-0992		25.4	34.9	1	1 3/8	3.0	10

** Note: Higher durometer values correlate with stiffer less flexible tubing.*

Tygon® Norprene®

- Best choice for long term peristaltic pump accuracy
- Repeatably autoclavable
- Wide temp. range -60°F to 275°F
- Opaque

Formulated for flexural resistance and high temperatures, Norprene® Tubing does not easily crack or deteriorate even in physically demanding applications.

Formulated to withstand high temperatures frequently, Norprene® Tubing will outlast and outperform virtually all other food grade tubings. Even following extended exposure to heat and ozone, Norprene® Tubing will not crack or deteriorate which is common when using traditional rubber tubings.

Extremely flexible, Norprene® Tubing resists kinks and retains its shape while installing quickly and easily. Its excellent flexural fatigue resistance makes it the absolute best choice for use in peristaltic pumps.

Repeatedly autoclavable, Norprene® Tubing can be steam cleaned in place, eliminating the need for frequent tubing replacement. When harsh sanitizing solutions are used, it exhibits exceptional chemical resistance and is entirely unaffected by a wide variety of cleaning solutions. Durometer hardness: Shore A, 61.*

Tygon Norprene		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-0946		1.6	4.8	1/16	3/16	15.2	50
BS4 72-0947		3.2	6.4	1/8	1/4	15.2	50
BS4 72-0948		4.8	7.9	3/16	5/16	15.2	50
BS4 72-0949		6.4	9.5	1/4	3/8	15.2	50
BS4 72-0950		6.4	12.7	1/4	1/2	15.2	50
BS4 72-0951		7.9	11.1	5/16	7/16	15.2	50
BS4 72-0952		9.5	12.7	3/8	1/2	15.2	50
BS4 72-0953		9.5	15.9	3/8	5/8	15.2	50
BS4 72-0954		12.7	19.1	1/2	3/4	15.2	50
BS4 72-0955		15.9	22.2	5/8	7/8	15.2	50
BS4 72-0956		19.1	25.4	3/4	1	15.2	50

Tygon® Laboratory Tubing (R-3603)

- Outstanding chemical resistance
- Lot-to-lot consistency for reproducible results
- Increases productivity in peristaltic pumps - outlasts other clear tubing 2 to 1

The most consistently reliable tubing for the transfer of liquids and gases, Tygon® Laboratory Tubing handles virtually all inorganic chemicals found in today's laboratories. Crystal-clear and flexible, Tygon® Laboratory Tubing handles virtually all inorganic chemicals found in the lab. It is non-oxidizing and non-contaminating. Long-lasting and crack-resistant, Tygon® Laboratory Tubing is less permeable than rubber tubing. The glassy-smooth inner bore helps prevent buildup so that cleaning is facilitated. Coils are marked at 1-foot intervals for easy measuring. Autoclavable. Remains flexible at -45°F (-43°C). Durometer hardness: Shore A, 55.*

Tygon R-3603		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-1014		0.8	2.4	1/32	3/32	15.2	50
BS4 72-1015		1.6	3.2	1/16	1/8	15.2	50
BS4 72-1016		1.6	4.8	1/16	3/16	15.2	50
BS4 72-1017		2.4	4.0	3/32	5/32	15.2	50
BS4 72-1018		2.4	5.6	3/32	7/32	15.2	50
BS4 72-1019		3.2	4.8	1/8	3/16	15.2	50
BS4 72-1020		3.2	6.4	1/8	1/4	15.2	50
BS4 72-1021		4.0	5.6	5/32	7/32	15.2	50
BS4 72-1022		4.0	7.1	5/32	9/32	15.2	50
BS4 72-1023		4.8	6.4	3/16	1/4	15.2	50
BS4 72-1024		4.8	7.9	3/16	5/16	15.2	50
BS4 72-1025		6.4	7.9	1/4	5/16	15.2	50
BS4 72-1026		6.4	9.5	1/4	3/8	15.2	50
BS4 72-1027		7.9	11.1	5/16	7/16	15.2	50
BS4 72-1028		7.9	14.3	5/16	9/16	15.2	50
BS4 72-4621		9.5	12.7	3/8	1/2	15.2	50
BS4 72-1029		9.5	14.3	3/8	9/16	15.2	50
BS4 72-1030		9.5	15.9	3/8	5/8	15.2	50
BS4 72-1031		11.1	15.9	7/16	5/8	15.2	50
BS4 72-1032		11.1	17.5	7/16	11/16	15.2	50
BS4 72-1033		12.7	17.5	1/2	11/16	15.2	50
BS4 72-1034		12.7	19.1	1/2	3/4	15.2	50
BS4 72-1035		14.3	19.1	9/16	3/4	15.2	50
BS4 72-1036		14.3	20.6	9/16	13/16	15.2	50
BS4 72-1037		15.9	20.6	5/8	13/16	15.2	50
BS4 72-1038		15.9	22.2	5/8	7/8	15.2	50
BS4 72-1039		17.5	22.2	11/16	7/8	15.2	50
BS4 72-1040		19.1	25.4	3/4	1	15.2	50
BS4 72-1041		19.1	27.0	3/4	1 1/16	15.2	50

** Note: Higher durometer values correlate with stiffer less flexible tubing.*

Tygon® B-44-4X Tubing

- Non-wetting surface permits thorough cleaning & complete drainage
- Smooth, non-porous bore will not trap particulates or promote bacterial growth
- Broad chemical resistance to virtually all non-solvent chemicals. Resistant to harsh alkaline cleaners and sanitizers.
- Excellent alternative to rigid piping systems but still lightweight and flexible enough for easy and quick installation
- Meets FDA, 3-A and NSF criteria

With its smooth, non-porous bore, B-44-4X Tubing ensures a bacterial-free fluid path in a wide variety of processing applications. Offers dependable performance in countless filling, draining, transfer and processing applications. Its smooth, non-porous bore in-hibits particle entrapment, promoting a sanitary fluid path by minimizing potential for bacterial growth. It has outstanding resistance to harsh alkaline cleaners and is equally unaffected by commonly used sanitizers. Complete clarity for positive visual inspection and flow control. Autoclavable, Gas (Ethylene Oxide). Durometer Hardness Shore A, 65.*

Tygon B-44-4X		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-0921		0.8	2.4	1/32	3/32	15.2	50
BS4 72-0922		1.6	3.2	1/16	1/8	15.2	50
BS4 72-0923		1.6	4.8	1/16	3/16	15.2	50
BS4 72-0924		2.4	4.0	3/32	5/32	15.2	50
BS4 72-0925		2.4	5.6	3/32	7/32	15.2	50
BS4 72-0926		3.2	4.8	1/8	3/16	15.2	50
BS4 72-0927		3.2	6.4	1/8	1/4	15.2	50
BS4 72-0928		4.0	5.6	5/32	7/32	15.2	50
BS4 72-0929		4.0	7.1	5/32	9/32	15.2	50
BS4 72-0930		4.8	6.4	3/16	1/4	15.2	50
BS4 72-0931		4.8	7.9	3/16	5/16	15.2	50
BS4 72-0932		6.4	7.9	1/4	5/16	15.2	50
BS4 72-0933		6.4	9.5	1/4	3/8	15.2	50
BS4 72-0934		7.9	11.1	5/16	7/16	15.2	50
BS4 72-0935		7.9	12.7	5/16	1/2	15.2	50
BS4 72-0936		9.5	14.3	3/8	9/16	15.2	50
BS4 72-0937		9.5	15.9	3/8	5/8	15.2	50
BS4 72-0938		11.1	14.3	7/16	9/16	15.2	50
BS4 72-0939		11.1	15.9	7/16	5/8	15.2	50
BS4 72-0940		12.7	17.5	1/2	11/16	15.2	50
BS4 72-0941		12.7	19.1	1/2	3/4	15.2	50
BS4 72-0942		14.3	19.1	9/16	3/4	15.2	50
BS4 72-0943		15.9	20.6	5/8	13/16	15.2	50
BS4 72-0944		15.9	22.2	5/8	7/8	15.2	50
BS4 72-0945		19.1	25.4	3/4	1	15.2	50

Tygon® PharMed® Tubing

- Outlasts silicone tubing in peristaltic pumps by up to 30 times
- Opaque
- Can be autoclaved repeatedly
- Heat weldable for sterile access in closed systems
- Meets USP Class VI, FDA and NSF criteria

Created with a unique combination of long flex life and biocompatibility, PharMed® Tubing is ideal for life science applications employing peristaltic pumps.

PharMed® Tubing is less permeable to gases and vapors than silicone tubing. It is ideal for cell culture, fermentation, synthesis, separation, purification and process monitoring and control. Independent tests show that PharMed® Tubing is safe for use in sensitive cell culture applications. It has very good general chemical resistance and excellent acid, alkali and oxidation resistance. Opaque to visible and UV light, it helps protect sensitive fluids. Continuous service temperature range is -60°F (-51°C) to 275°F (135°C). Durometer hardness: Shore A, 64.*

Tygon Pharmed		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-0957		0.5	3.7	0.020	0.144	7.6	25
BS4 72-0958		0.8	4.0	1/32	5/32	7.6	25
BS4 72-0959		1.6	3.2	1/16	1/8	7.6	25
BS4 72-0960		1.6	4.8	1/16	3/16	7.6	25
BS4 72-0961		2.4	5.6	3/32	7/32	7.6	25
BS4 72-0962		3.2	4.8	1/8	3/16	7.6	25
BS4 72-0963		3.2	6.4	1/8	1/4	7.6	25
BS4 72-0964		4.8	7.9	3/16	5/16	7.6	25
BS4 72-0965		6.4	9.5	1/4	3/8	7.6	25
BS4 72-0966		6.4	12.7	1/4	1/2	7.6	25
BS4 72-0967		7.9	11.1	5/16	7/16	7.6	25
BS4 72-0968		9.5	12.7	3/8	1/2	7.6	25
BS4 72-0969		9.5	15.9	3/8	5/8	7.6	25
BS4 72-0970		12.7	19.1	1/2	3/4	7.6	25
BS4 72-0971		15.9	22.2	5/8	7/8	7.6	25
BS4 72-0972		19.1	25.4	3/4	1	7.6	25

Tygon® Medical/Surgical Tubing (S-50-HL)

- Crystal clear
- Ideal for blood contact
- Flexible and resilient with established performance in peristaltic pump apps
- Fully characterized to ISO 10993 and FDA guidelines for biocompatibility
- Meets USP Class VI criteria

Crystal clear Tygon® Medical/Surgical Tubing provides proven performance in countless medical device applications.

Originally developed for use in cardiac surgery, Tygon® Medical/Surgical Tubing's consistent quality provides dependable performance in medical device applications. It has been fully tested for biological safety to the ISO 10993 standard.

Tygon® Medical/Surgical Tubing can be sterilized by radiation, ethylene oxide, steam or chemical methods. Durometer hardness: Shore A, 66.*

Tygon S-50-HL		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-1248		1.6	3.2	1/16	1/8	15.2	50
BS4 72-1252		1.8	3.4	1/14	2/15	15.2	50
BS4 72-1249		2.4	4.0	3/32	5/32	15.2	50
BS4 72-1253		4.0	5.6	5/32	7/32	15.2	50
BS4 72-1251		4.8	6.4	3/16	1/4	15.2	50
BS4 72-1255		4.8	7.9	3/16	5/16	15.2	50
BS4 72-1254		5.6	7.1	7/32	9/32	15.2	50
BS4 72-1257		5.6	8.7	7/32	11/32	15.2	50
BS4 72-1250		6.4	7.9	1/4	5/16	15.2	50
BS4 72-1259		6.4	9.5	1/4	3/8	15.2	50
BS4 72-1258		7.1	10.3	9/32	13/32	15.2	50
BS4 72-1262		7.9	11.1	5/16	7/16	15.2	50
BS4 72-1256		9.5	12.7	3/8	1/2	15.2	50
BS4 72-1260		11.1	14.3	7/16	9/16	15.2	50
BS4 72-1263		12.7	17.5	1/2	11/16	15.2	50
BS4 72-1265		12.7	17.5	1/2	11/16	15.2	50
BS4 72-1261		14.3	17.5	9/16	11/16	15.2	50
BS4 72-1264		14.3	19.1	9/16	3/4	15.2	50
BS4 72-1267		15.9	20.6	5/8	13/16	15.2	50
BS4 72-1270		15.9	22.2	5/8	7/8	15.2	50
BS4 72-1272		19.1	23.8	3/4	15/16	15.2	50
BS4 72-1268		19.1	25.4	3/4	1	15.2	50
BS4 72-1266		20.6	25.4	13/16	1	15.2	50
BS4 72-1271		22.2	28.6	7/8	1 1/8	15.2	50
BS4 72-1269		25.4	31.8	1	1 1/4	15.2	50

Tygon® Ultra-Soft Tubing (R-1000)

- Ultra-soft and flexible
- Performs well at low temperatures (to -100°F)
- Excellent for use in low-torque pump applications
- Ideal for use in Harvard's Pump 66 and Pump 77 peristaltic pumps, see page 33

Tygon® Ultra-Soft Tubing provides unmatched flexibility and drapability-characteristics beneficial to numerous laboratory set-ups.

Tygon® Ultra-Soft Tubing resists a broad range of aqueous chemicals and provides an excellent alternative to silicone tubing in applications where corrosive chemicals are used. Its minimal resistance to compression permits use in low-torque pump applications including battery driven types. Tygon® Ultra-Soft Tubing stays flexible at temperatures as low as -100°F (-73°C). Its smooth bore facilitates easy cleaning and helps prevent possible buildup. Do not autoclave. Durometer hardness: Shore A, 40.*

Tygon R-1000		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-0998		1.6	4.8	1/16	3/16	15.2	50
BS4 72-0999		3.2	6.4	1/8	1/4	15.2	50
BS4 72-1000		4.8	7.9	3/16	5/16	15.2	50
BS4 72-1001		6.4	9.5	1/4	3/8	15.2	50
BS4 72-1002		6.4	12.7	1/4	1/2	15.2	50
BS4 72-1003		7.9	11.1	5/16	7/16	15.2	50
BS4 72-1004		9.5	12.7	3/8	1/2	15.2	50
BS4 72-1005		9.5	15.9	3/8	5/8	15.2	50
BS4 72-1006		12.7	15.9	1/2	5/8	15.2	50
BS4 72-1007		12.7	19.1	1/2	3/4	15.2	50

** Note: Higher durometer values correlate with stiffer less flexible tubing.*

Tygon® Ultra Chemical Resistant Tubing (2075)

- Suitable for most gas anesthesia applications
- Temperature resistant from -60°F to 275°F
- Compatible with virtually all common sanitizers and cleaners
- Can be autoclaved repeatedly
- Meets FDA, 3-A and NSF criteria

After being immersed in aggressive MEK for 16 hours (plus 4 hours drying time), Tygon® Ultra Chemical Resistant Tubing is still clear and flexible while PVC tubing is completely degraded and rendered useless.

Tygon® Ultra Chemical Resistant Tubing offers an unequaled combination of chemical resistance, clarity and flexibility. It is virtually unaffected by acids, bases, ketones, salts and alcohols, fitting the requirements of many applications from acids to hazardous material handling. It's entirely plasticizer-free, eliminating fluid contamination and the premature embrittlement and cracking common with many types of flexible tubing. Its exceptionally smooth inner surface inhibits particulate buildup and reduces the potential for contamination. Durometer hardness: Shore A, 72.*

Tygon 2075		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-0973		1.6	4.8	1/16	3/16	15.2	50
BS4 72-0974		3.2	6.4	1/8	1/4	15.2	50
BS4 72-0975		4.8	7.9	3/16	5/16	15.2	50
BS4 72-0976		6.4	9.5	1/4	3/8	15.2	50
BS4 72-0977		7.9	11.1	5/16	7/16	15.2	50
BS4 72-0978		9.5	12.7	3/8	1/2	15.2	50
BS4 72-0979		12.7	19.1	1/2	3/4	15.2	50
BS4 72-0980		15.9	22.2	5/8	7/8	15.2	50
BS4 72-0981		19.1	25.4	3/4	1	15.2	50
BS4 72-0982		25.4	34.9	1	1 3/8	7.6	25

** Note: Higher durometer values correlate with stiffer less flexible tubing.*

Tygon® Fluran® Severe Environment Tubing

- Provides continuous service at temperatures up to 400°F (204°C)
- Excellent resistance to corrosive chemicals, oils, fuels and solvents
- Resists ozone, sunlight and weathering
- Opaque black color helps protect light sensitive fluids

Resistant to corrosive chemicals and solvents, Fluran® Severe Environment Tubing is designed to handle the most aggressive solutions at temperatures as high as 400°F.

Made of a proprietary fluoroelastomer, Fluran® Severe Environment Tubing has both the physical and chemical properties that make it ideal for severe environments, such as dry cleaning fluid lines and solvent recovery systems, where other flexible tubings fail. Fluran® Severe Environment Tubing can be used in continuous service with temperatures as high as 400°F (204°C) and has excellent resistance to corrosive chemicals, oils, fuels, solvents and most mineral acids.

This opaque black tubing helps protect light-sensitive materials being transferred and will not prematurely crack and age when exposed to ozone, sun and weather. It is highly flexible and resilient, making it the ideal choice in peristaltic pumping of extremely corrosive materials. A food grade formulation is available upon request. Durometer hardness: Shore A, 60.*

Tygon Fluran		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-1008		1.6	3.2	1/16	1/8	15.2	50
BS4 72-1009		3.2	6.4	1/8	1/4	15.2	50
BS4 72-1010		4.8	7.9	3/16	5/16	15.2	50
BS4 72-1011		6.4	9.5	1/4	3/8	15.2	50
BS4 72-1012		7.9	11.1	5/16	7/16	15.2	50
BS4 72-1013		9.5	12.7	3/8	1/2	15.2	50

Platinum Cured Silicone Tubing

- Excellent for use as catheters, drains and IV drug delivery
- Ultra-pure biocompatible tubing
- Autoclavable
- Resistant to temperature extremes

This Platinum Cured Silicone tubing is ultra-flexible and can be sterilized by autoclaving. It is an ultra-pure biopharmaceutical grade tubing which imparts no tastes or odors to fluids transferred. Resistant to temperature extremes, ozone, radiation, moisture, compression sets, weathering, and chemical attack. Ideal for applications such as sterile fill and transfers, biocompatible for use as catheters, drains and intravenous drug delivery and blood withdrawal. Non-toxic and non-hemolytic.

Platinum Cured Silicone		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-1042		0.3	0.6	0.012	0.024	7.6	25
BS4 72-1043	0.5	0.9	0.020	0.036	7.6	25	
BS4 72-1044	0.6	1.2	0.025	0.047	7.6	25	
BS4 72-1045	0.8	1.7	0.030	0.066	7.6	25	
BS4 72-1046	0.8	4.1	0.030	0.160	7.6	25	
BS4 72-4189	0.8	2.4	1/32	3/32	15.2	50	
BS4 72-1047	1.0	2.2	0.040	0.086	7.6	25	
BS4 72-1048	1.5	1.9	0.058	0.076	7.6	25	
BS4 72-1050	1.6	3.2	1/16	1/8	7.6	25	
BS4 72-1049	1.6	4.8	1/16	3/16	7.6	25	
BS4 72-1054	1.6	6.4	1/16	1/4	7.6	25	
BS4 72-1052	1.6	7.9	1/16	5/16	7.6	25	
BS4 72-1053	1.6	11.1	1/16	7/16	7.6	25	
BS4 72-1051	1.6	14.3	1/16	9/16	7.6	25	
BS4 72-1056	2.0	3.6	5/64	9/64	7.6	25	
BS4 72-1055	2.0	5.2	5/64	13/64	7.6	25	
BS4 72-1060	2.0	6.7	5/64	17/64	7.6	25	
BS4 72-1058	2.0	8.3	5/64	21/64	7.6	25	
BS4 72-1059	2.0	11.5	5/64	29/64	7.6	25	
BS4 72-1057	2.0	14.7	5/64	37/64	3.0	10	
BS4 72-1062	2.4	4.0	3/32	5/32	7.6	25	
BS4 72-1061	2.4	5.6	3/32	7/32	7.6	25	
BS4 72-1066	2.4	7.1	3/32	9/32	7.6	25	
BS4 72-1064	2.4	8.7	3/32	11/32	7.6	25	

* *Note: Other tubing sizes available. Please visit our website or contact us for more information.*

Platinum Cured Silicone Tubing (Continued)

Platinum Cured Silicone		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-1065		2.4	11.9	3/32	15/32	7.6	25
BS4 72-1063		2.4	15.1	3/32	19/32	7.6	25
BS4 72-1068		3.2	4.8	1/8	3/16	7.6	25
BS4 72-1067		3.2	6.4	1/8	1/4	7.6	25
BS4 72-1072		3.2	7.9	1/8	5/16	7.6	25
BS4 72-1070		3.2	9.5	1/8	3/8	7.6	25
BS4 72-1071		3.2	12.7	1/8	1/2	7.6	25
BS4 72-1069		3.2	15.9	1/8	5/8	7.6	25
BS4 72-1074		4.0	5.6	5/32	7/32	7.6	25
BS4 72-1073		4.0	7.1	5/32	9/32	7.6	25
BS4 72-1078		4.0	8.7	5/32	11/32	7.6	25
BS4 72-1076		4.0	10.3	5/32	13/32	7.6	25
BS4 72-1077		4.0	13.5	5/32	17/32	7.6	25
BS4 72-1075		4.0	16.7	5/32	21/32	3.0	10
BS4 72-1080		4.8	6.4	3/16	1/4	7.6	25
BS4 72-1079		4.8	7.9	3/16	5/16	7.6	25
BS4 72-1084		4.8	9.5	3/16	3/8	7.6	25
BS4 72-1082		4.8	11.1	3/16	7/16	7.6	25
BS4 72-1083		4.8	14.3	3/16	9/16	7.6	25
BS4 72-1081		4.8	17.5	3/16	11/16	3.0	10
BS4 72-1086		6.4	7.9	1/4	5/16	7.6	25
BS4 72-1085		6.4	9.5	1/4	3/8	7.6	25
BS4 72-1090		6.4	11.1	1/4	7/16	7.6	25
BS4 72-1088		6.4	12.7	1/4	1/2	7.6	25
BS4 72-1089		6.4	15.9	1/4	5/8	3.0	10
BS4 72-1087		6.4	19.1	1/4	3/4	3.0	10
BS4 72-1092		7.9	9.5	5/16	3/8	7.6	25
BS4 72-1091		7.9	11.1	5/16	7/16	7.6	25
BS4 72-1096		7.9	12.7	5/16	1/2	3.0	10
BS4 72-1094		7.9	14.3	5/16	9/16	3.0	10
BS4 72-1095		7.9	17.5	5/16	11/16	3.0	10
BS4 72-1093		7.9	20.6	5/16	13/16	3.0	10
BS4 72-1098		9.5	11.1	3/8	7/16	7.6	25
BS4 72-1097		9.5	12.7	3/8	1/2	3.0	10
BS4 72-1102		9.5	14.3	3/8	9/16	3.0	10
BS4 72-1100		9.5	15.9	3/8	5/8	3.0	10
BS4 72-1101		9.5	19.1	3/8	3/4	3.0	10
BS4 72-1099		9.5	22.2	3/8	7/8	3.0	10
BS4 72-1104		12.7	14.3	1/2	9/16	3.0	10
BS4 72-1103		12.7	15.9	1/2	5/8	3.0	10
BS4 72-1108		12.7	17.5	1/2	11/16	3.0	10
BS4 72-1106		12.7	19.1	1/2	3/4	3.0	10

Platinum Cured Silicone		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-1107		12.7	22.2	1/2	7/8	3.0	10
BS4 72-1105		12.7	25.4	1/2	1	3.0	10
BS4 72-1109		15.9	17.5	5/8	11/16	3.0	10
BS4 72-1110		15.9	19.1	5/8	3/4	3.0	10
BS4 72-1114		15.9	19.1	5/8	3/4	3.0	10
BS4 72-1112		15.9	20.6	5/8	13/16	3.0	10
BS4 72-1113		15.9	22.2	5/8	7/8	3.0	10
BS4 72-1111		15.9	25.4	5/8	1	3.0	10
BS4 72-1115		19.1	20.6	3/4	13/16	3.0	10
BS4 72-1120		19.1	22.2	3/4	7/8	3.0	10
BS4 72-1118		19.1	23.8	3/4	15/16	3.0	10
BS4 72-1119		19.1	25.4	3/4	1	3.0	10
BS4 72-1116		19.1	28.6	3/4	1 1/8	3.0	10
BS4 72-1117		19.1	28.6	3/4	1 1/8	3.0	10
BS4 72-1121		22.2	23.8	7/8	15/16	3.0	10
BS4 72-1126		22.2	25.4	7/8	1	3.0	10
BS4 72-1124		22.2	27.0	7/8	1 1/16	3.0	10
BS4 72-1125		22.2	28.6	7/8	1 1/8	3.0	10
BS4 72-1122		22.2	31.8	7/8	1 1/4	3.0	10
BS4 72-1123		22.2	31.8	7/8	1 1/4	3.0	10
BS4 72-1127		25.4	27.0	1	1 1/16	3.0	10
BS4 72-1132		25.4	28.6	1	1 1/8	3.0	10
BS4 72-1130		25.4	31.8	1	1 1/4	3.0	10
BS4 72-1128		25.4	34.9	1	1 3/8	3.0	10
BS4 72-1131		25.4	34.9	1	1 3/8	3.0	10
BS4 72-1129		25.4	38.1	1	1 1/2	3.0	10

FEP Semi-Flexible Tubing

- Excellent chemical resistance even at extreme temperatures from -348°F to 392°F
- UV and ozone resistant
- Low protein adsorption
- FDA compliant/USP Class VI

With excellent resistance to chemicals, ozone and UV radiation, FEP tubing maintains its chemical resistance even at extreme temperatures. Its superior non-stick characteristics ease the transfer of product lowering the incidence of protein binding/absorption. Ideal for the transfer of fluids like synthetic peptides and antibodies whose protein composition must be maintained to exacting tolerances.

FEP Tubing		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-1169		1.6	3.2	1/16	1/8	7.6	25
BS4 72-1188		1.6	4.8	1/16	3/16	7.6	25
BS4 72-1174		2.4	2.4	3/32	3/32	7.6	25
BS4 72-1175		2.4	4.0	3/32	5/32	7.6	25
BS4 72-1172		3.2	4.8	1/8	3/16	7.6	25
BS4 72-1189		3.2	6.4	1/8	1/4	7.6	25
BS4 72-1179		4.0	6.4	5/32	1/4	7.6	25
BS4 72-1173		4.8	6.4	3/16	1/4	7.6	25
BS4 72-1190		4.8	7.9	3/16	5/16	7.6	25
BS4 72-1171		6.4	7.9	1/4	5/16	7.6	25
BS4 72-1191		6.4	9.5	1/4	3/8	7.6	25
BS4 72-1178		7.9	9.5	5/16	3/8	3.0	10
BS4 72-1192		7.9	11.1	5/16	7/16	3.0	10
BS4 72-1177		9.5	11.1	3/8	7/16	3.0	10
BS4 72-1193		9.5	12.7	3/8	1/2	3.0	10
BS4 72-1176		11.1	12.7	7/16	1/2	3.0	10
BS4 72-1170		12.7	14.3	1/2	9/16	3.0	10
BS4 72-1195		12.7	15.9	1/2	5/8	3.0	10
BS4 72-1184		14.3	15.9	9/16	5/8	3.0	10
BS4 72-1196		14.3	17.5	9/16	11/16	3.0	10
BS4 72-1180		15.9	17.5	5/8	11/16	3.0	10
BS4 72-1197		15.9	19.1	5/8	3/4	3.0	10
BS4 72-1182		17.5	19.1	11/16	3/4	3.0	10
BS4 72-1198		17.5	20.6	11/16	13/16	3.0	10
BS4 72-1181		19.1	20.6	3/4	13/16	3.0	10
BS4 72-1199		19.1	22.2	3/4	7/8	3.0	10
BS4 72-1183		22.2	23.8	7/8	15/16	3.0	10
BS4 72-1200		22.2	25.4	7/8	1	3.0	10
BS4 72-1187		25.4	27.0	1	1 1/16	3.0	10
BS4 72-1201		25.4	28.6	1	1 1/8	3.0	10
BS4 72-1186		31.8	33.3	1 1/4	1 5/16	3.0	10
BS4 72-1202		31.8	34.9	1 1/4	1 3/8	3.0	10
BS4 72-1185		38.1	39.7	1 1/2	1 9/16	3.0	10
BS4 72-1203		38.1	41.3	1 1/2	1 5/8	3.0	10
BS4 72-1204		50.8	54.0	2	2 1/8	3.0	10

PFA Semi-Flexible Tubing

- Excellent chemical resistance
- UV and ozone resistant
- Suitable for a wide range of temperature applications from -320°F to 500°F
- FDA compliant/USP Class VI

PFA tubing has better flex life and mechanical characteristics at elevated temperatures versus traditional PTFE tubing. Like FEP tubing it has superior chemical and environmental (UV and Ozone) resistance with a higher working temperature range than FEP.

PFA Tubing		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-1134		1.6	3.2	1/16	1/8	7.6	25
BS4 72-1153		1.6	4.8	1/16	3/16	7.6	25
BS4 72-1135		2.4	4.0	3/32	5/32	7.6	25
BS4 72-1136		3.2	4.8	1/8	3/16	7.6	25
BS4 72-1154		3.2	6.4	1/8	1/4	7.6	25
BS4 72-1137		4.0	6.4	5/32	1/4	7.6	25
BS4 72-1138		4.8	6.4	3/16	1/4	7.6	25
BS4 72-1155		4.8	7.9	3/16	5/16	7.6	25
BS4 72-1139		6.4	7.9	1/4	5/16	3.0	10
BS4 72-1156		6.4	9.5	1/4	3/8	3.0	10
BS4 72-1140		7.9	9.5	5/16	3/8	3.0	10
BS4 72-1157		7.9	11.1	5/16	7/16	3.0	10
BS4 72-1141		9.5	11.1	3/8	7/16	3.0	10
BS4 72-1158		9.5	12.7	3/8	1/2	3.0	10
BS4 72-1142		11.1	12.7	7/16	1/2	3.0	10
BS4 72-1159		11.1	14.3	7/16	9/16	3.0	10
BS4 72-1143		12.7	14.3	1/2	9/16	3.0	10
BS4 72-1160		12.7	15.9	1/2	5/8	3.0	10
BS4 72-1147		14.3	15.9	9/16	5/8	3.0	10
BS4 72-1168		14.3	17.5	9/16	11/16	3.0	10
BS4 72-1144		15.9	17.5	5/8	11/16	3.0	10
BS4 72-1166		15.9	19.1	5/8	3/4	3.0	10
BS4 72-1145		17.5	19.1	11/16	3/4	3.0	10
BS4 72-1161		17.5	20.6	11/16	13/16	3.0	10
BS4 72-1146		19.1	20.6	3/4	13/16	3.0	10
BS4 72-1165		19.1	22.2	3/4	7/8	3.0	10
BS4 72-1148		22.2	23.8	7/8	15/16	3.0	10
BS4 72-1167		22.2	25.4	7/8	1	3.0	10
BS4 72-1149		25.4	27.0	1	1 1/16	3.0	10
BS4 72-1152		25.4	28.6	1	1 1/8	3.0	10
BS4 72-1150		31.8	33.3	1 1/4	1 5/16	3.0	10
BS4 72-1163		31.8	34.9	1 1/4	1 3/8	3.0	10
BS4 72-1151		38.1	39.7	1 1/2	1 9/16	3.0	10
BS4 72-1162		38.1	41.3	1 1/2	1 5/8	3.0	10
BS4 72-1164		50.8	54.0	2	2 1/8	3.0	10

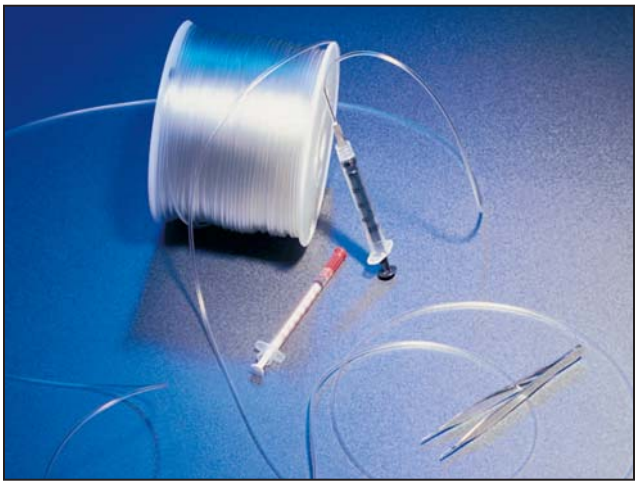
Kynar/PVDF Tubing (Polyvinylidene Fluoride)

- High Purity
- Excellent chemical and environmental resistance
- Low permeability with most gases and liquids
- FDA compliant/USP Class VI

PVDF tubing is ideal for fluid applications which require a high degree of purity such as the transfer of ultra-pure deionized water. Thinner walled PVDF tubing is translucent making it easier to confirm fluid movement. Thin wall PVDF tubing is also more flexible than FEP and PFA tubing but does not have as broad a working temperature range.

Kynar/PVDF Tubing		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-1205		1.6	3.2	1/16	1/8	7.6	25
BS4 72-1206		3.2	4.8	1/8	3/16	7.6	25
BS4 72-1211		3.2	6.4	1/8	1/4	7.6	25
BS4 72-1208		4.3	6.4	8/47	1/4	7.6	25
BS4 72-1207		4.8	6.4	3/16	1/4	7.6	25
BS4 72-1212		4.8	7.9	3/16	5/16	7.6	25
BS4 72-1213		6.4	9.5	1/4	3/8	3.0	10
BS4 72-1209		7.9	9.5	5/16	3/8	7.6	25
BS4 72-1214		7.9	11.1	5/16	7/16	3.0	10
BS4 72-1215		9.5	12.7	3/8	1/2	3.0	10
BS4 72-1210		11.1	12.7	7/16	1/2	7.6	25
BS4 72-1216		12.7	15.9	1/2	5/8	3.0	10
BS4 72-1217		15.9	19.1	5/8	3/4	3.0	10
BS4 72-1218		19.1	22.2	3/4	7/8	3.0	10
BS4 72-1219		22.2	25.4	7/8	1	3.0	10
BS4 72-1220		25.4	31.8	1	1 1/4	3.0	10

Tygon® Microbore Tubing (S-54-HL)



- Stiff enough for easy handling, soft enough to resist puncturing
- Micro-diameter sizes fit needle gauges 30 to 17
- Ideal for precision injection and dispensing applications
- Meets USP Class VI criteria

Tygon® Microbore Tubing is designed for precision injection and dispensing in surgical and laboratory applications.

Select Tygon® Microbore Tubing for intravenous and arterial infusion as well as other surgical and laboratory applications. It is flexible enough to permit the use of a single size tubing with several different needle gauges, yet sufficiently rigid to minimize the danger of wall collapse. Tygon® Microbore Tubing is non-toxic, non-pyrogenic and biocompatible. Tygon® Microbore Tubing can be sterilized by radiation, ethylene oxide, steam or chemical methods. Durometer hardness: Shore A, 83.*

Tygon S-54-HL		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 72-0993		0.3	0.8	0.010	0.030	152.4	500
BS4 72-0994		0.5	1.5	0.020	0.060	152.4	500
BS4 72-0995		0.8	2.3	0.030	0.090	152.4	500
BS4 72-0996		1.0	1.8	0.040	0.070	152.4	500
BS4 72-0997		1.3	2.3	0.050	0.090	152.4	500

Did you know?

Harvard Apparatus now owns Clark Electromedical. See pages M47 to M49 in the Cell Biology Section for the industry standard capillary glass.

Did you know?

Harvard Apparatus has new nitric oxide sensors that have 100 times the sensitivity of any existing nitric oxide sensors. See pages M2 to M4 in the Cell Biology Section for complete details.

Micro-Line™ Tubing

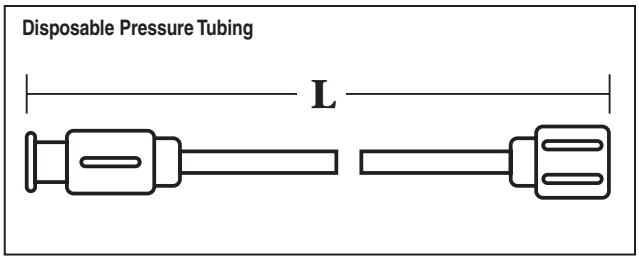
This remarkable new cross-linked Ethyl Vinyl Acetate Tubing is ideal for biological use. It is stable, non-contaminating and contains no plasticizers that could migrate or leach out.

The mechanical properties of this material are unique. It has virtually 100% elastic memory and will return to its original shape after stretching by gentle heating. It will stretch to fit over tubes and fittings. Micro-Line™ Tubing can be shaped with heat to form various shapes or can be cold-stretched to reduce the internal diameter by 40%. Tubing is flexible and non-kinking from below zero to 180°F.

The Tubing can be sterilized by autoclaving, dry heat, radiation or ethylene oxide gas sterilization and is supplied in 30 m (100 ft) spools.

Micro-Line™ Tubing		mm		inches		Length	
Catalog No.	$	ID	OD	ID	OD	m	ft
BS4 59-8642		0.5	1.5	0.020	0.060	30.5	100
BS4 59-8643		0.8	2.3	0.030	0.090	30.5	100
BS4 59-8644		1.0	1.8	0.040	0.070	30.5	100
BS4 59-8645		1.3	2.3	0.050	0.090	30.5	100
BS4 59-8646		Set of 4 spools, one of each of the sizes above.					

Disposable Pressure Tubing



- Ideal for infusion studies
- Easily extend infusion lines from syringe to needle or catheter

This Pressure Tubing is the ideal way to connect the output from a syringe to the delivery mechanism for an infusion study. It has a male Luer Lock connector on one end and a female Luer Lock connector on the other. Tubing volume is 0.6 ml per 12 inches of tubing. It is available in 8 lengths and is supplied sterile in packages of 25.

Catalog No.	$	Product
BS4 63-0281		15.2 cm (6 in)
BS4 63-0282		30.5 cm (12 in)
BS4 63-0283		61 cm (24 in)
BS4 63-0284		91.4 cm (36 in)
BS4 63-0285		121.9 cm (48 in)
BS4 63-0286		152.4 cm (60 in)
BS4 63-0287		182.9 cm (72 in)
BS4 63-0288		213.4 cm (84 in)

Disposable High Pressure Tubing

This Tubing is similar to the tubing described above except it can withstand pressures up to 1000 p.s.i. It has a male Luer Lock connector on one end and a female on the other. Lengths of 10 to 30 inches are supplied straight. Lengths of 40 and 60 inches are supplied coiled. Supplied in a package of 10.

Catalog No.	$	Product
BS4 63-0297		25.4 cm (10 in)
BS4 63-0298		50.8 cm (20 in)
BS4 63-0299		76.2 cm (30 in)
BS4 63-0300		101.6 cm (40 in)
BS4 63-0301		152.4 cm (60 in)

Laboratory Tubing

Harvard Apparatus' PolyE polyethylene tubing is an excellent tubing choice for a variety of applications requiring small ID or OD tubing. It can be used for infusions, tracheotomies or other surgical operations in rodents from mice to rabbits. Cross reference numbers to PE tubing is provided. Blunt probe needles can be used with this tubing to make custom cannulae. Information in the table will assist in needle selection. One column lists the size of needle which will fit into the tubing while the other column lists the size of needle through which each tubing size will pass.

Sterile PolyE Polyethylene Tubing

	Length 30.5 cm (12 in)	91.45 cm (36 in)	PE No.	Diameter ID x OD	Needle Gauge Needle In Tubing	Needle Gauge Tubing In Needle
$	BS4 59-8357	BS4 59-8358	50	0.58 x 0.965 mm (0.023 x 0.038 in)	23 g	17 g
$		BS4 59-8360	90	0.86 x 1.27 mm (0.034 x 0.050 in)	20 g	15 g
$		BS4 59-8364	190	1.19 x 1.70 mm (0.047 x 0.067 in)	18 g	13 g
$		BS4 59-8370	240	1.67 x 2.42 mm (0.066 x 0.095 in)	15 g	10 g

Use this chart below to determine comparable sizes of PolyE and French scale tubing

French* Number	PolyE Number	OD (in)	French* Number	PolyE Number	OD (in)
1	-	0.013	6.2	420	0.082
1.8	100	0.024	7	-	0.092
2	-	0.026	7.2	460	0.095
2.4	140	0.031	8	-	0.105
2.9	200	0.038	8.1	380	0.106
3	160	0.039	8.4	500	0.118
3.3	120	0.043	9.8	520	0.128
3.7	240	0.048	10	-	0.131
3.8	260	0.050	11	540	0.145
4	-	0.052	11.7	605	0.153
4.6	280	0.060	12.3	580	0.161
4.7	320	0.062	13	-	0.171
5	-	0.066	14	-	0.184
5.1	340	0.067	15	-	0.197
5.7	360	0.075	16	-	0.210
5.9	300	0.078	17	-	0.223
6	-	0.079	18	680	0.236

** French Scale = OD (in) x 76.211 - 0.0014*

Non-Sterile PolyE Polyethylene Tubing

Tubing Length 3 m (10 ft)	$	30.5 m (100 ft)	$	PolyE No.	Diameter ID x OD mm (in)	Size French Scale*	Needle Gauge Needle into Tubing	Needle Gauge Tubing into Needle	PE # Equiv.
BS4 59-8321		BS4 59-8322		100	0.28 x 0.61 (0.011 x 0.024)	1.8	30 g	20 g	10
BS4 59-8323		BS4 59-8324		120	0.38 x 1.09 (0.015 x 0.042)	3.2	27 g	16 g	20
BS4 72-0191		BS4 72-0192		140	0.40 x 0.80 (0.016 x 0.031)	2.4	26 g	18 g	-
BS4 72-0193		BS4 72-0194		160	0.50 x 1.00 (0.02 x 0.039)	3.0	24 g	17 g	-
BS4 59-8325		BS4 59-8326		200	0.58 x 0.96 (0.023 x 0.038)	2.9	23 g	17 g	50
BS4 59-8327		BS4 59-8328		240	0.76 x 1.22 (0.030 x 0.048)	3.7	21 g	15 g	60
BS4 59-8329		BS4 59-8330		260	0.86 x 1.27 (0.034 x 0.050)	3.8	20 g	15 g	90
BS4 59-8331		BS4 59-8332		280	0.86 x 1.52 (0.034 x 0.060)	4.6	20 g	14 g	100
BS4 72-0195		BS4 72-0196		300	1.02 x 1.98 (0.04 x 0.078)	5.9	18 g	12 g	-
BS4 59-8333		BS4 59-8334		320	1.14 x 1.57 (0.045 x 0.062)	4.7	18 g	14 g	160
BS4 59-8335		BS4 59-8336		340	1.19 x 1.70 (0.047 x 0.067)	5.1	18 g	14 g	190
BS4 59-8337		BS4 59-8338		360	1.40 x 1.90 (0.055 x 0.075)	5.7	17 g	12 g	200
BS4 72-0197		BS4 72-0198		380	1.50 x 2.70 (0.059 x 0.106)	8.1	16 g	10 g	-
BS4 59-8339		BS4 59-8340		420	1.57 x 2.08 (0.062 x 0.082)	6.2	16 g	12 g	205
BS4 59-8341		BS4 59-8342		460	1.67 x 2.42 (0.066 x 0.095)	7.2	14 g	10 g	240
BS4 59-8343		BS4 59-8344		500	2.0 x 3.0 (0.079 x 0.118)	9.0	14 g	8 g	260
BS4 59-8345		BS4 59-8346		520	2.16 x 3.25 (0.085 x 0.128)	9.8	13 g	8 g	280
BS4 59-8347		BS4 59-8348		540	2.45 x 3.7 (0.096 x 0.145)	11.1	12 g	7 g	320
BS4 59-8349		BS4 59-8350		580	2.8 x 4.1 (0.110 x 0.161)	12.3	11 g	6 g	330
BS4 59-8351		BS4 59-8352		605	3.0 x 3.88 (0.118 x 0.153)	11.6	10 g	6 g	350
BS4 59-8355		BS4 59-8356		680	4.0 x 6.0 (0.157 x 0.236)	17.9	9 g	NA	380

** French Scale = OD (in) x 76.211 - 0.0014*

Barbed Tubing Connectors

Luer and Barbed Connector Kits

Tubing Connector Kits and Stopcocks

Harvard Apparatus now offers a complete line of tubing connector kits to assist you in quickly and easily making connections between syringes and tubing and between tubing of similar and dissimilar sizes. Kit types include: tube to tube kits (small, medium and large), Kent Systems™ Quick Disconnect Kits, luer connector kits, a stopcock and check valve kit, a luer specialty connector kit and a tubing clamp kit. Some kits are available in multiple material types where chemical compatibility may be a concern. Each kit is supplied in a convenient storage box and each kit component is also sold separately (see our website or CD-ROM catalog for complete listing of kit components). Our line of connectors grows continually. Visit our website for the latest offerings.

Kent® Systems Quick Disconnect Kits

These kits feature the Kent® Systems quick disconnect (KSQD) fittings. Fittings are available as either male or female KSQD. Fitting styles include integral male or female, swivel male (with or without lock), locking male fitting, male to female KSQD shut-off valve, male plug, male/female plug, male flush plug, female cap, male flush plug and the modular manifold. The modular manifold has three female and one male KSQD fittings. Modular manifolds can be interconnected with any fitting including other modular manifolds to quickly and easily interconnect a number of tubes of similar or dissimilar sizes. The unique barbs are sized to accommodate a range of tube sizes and tube types. All kits are supplied in a convenient box.

Kent® Systems Quick Disconnect Kits Barb Size Chart

		Barb Bore		
Barb No.	Barb OD	Lower	Upper	Tube ID Range
004	0.102 in	0.06 in	0.063 in	0.078 in
007	0.129 in	0.076 in	0.078 in	0.109 in
013	0.164 in	0.096 in	0.094 in	0.141 in
025	0.208 in	0.122 in	0.125 in	0.188 in
035	0.264 in	0.155 in	0.156 in	0.234 in
055	0.335 in	0.197 in	0.188 in	0.297 in

Kent® Systems Quick Disconnect Kits

Catalog No.	$	Barb Size	Kit Size	Tube ID Range
BS4 72-1613		004, 007, 013	Small	1/16, 3/32 and 1/8 in
BS4 72-1614		025, 035, 055	Large	5/32, 3/16 and 1/8 in


BS4 72-1409 Small Kit


BS4 72-1412 Medium Kit

Barbed Connector Kits

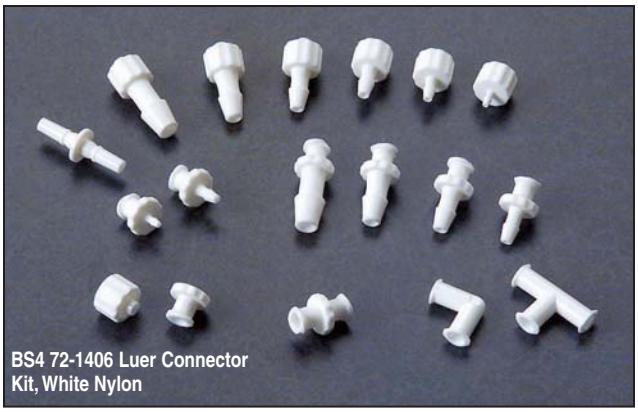
These barbed connector kits come in three different size ranges: Small fittings for 1/16, 3/32 and 1/8 inch ID tubing, medium fittings for 1/4, 5/16, 3/8 inch ID tubing and large fittings 1/2 and 5/8 inch ID tubing. Small and medium kits have 10 pieces of each component and large kits have 5 pieces of each component. Kit components include tube to tube connectors, tube to tube reducing adapters, Y-, T- and L-connectors and Y-, T- and L-reducing adapters and tubing plugs. Connectors join tubing of similar size while reducing adapters join tubing of different size. Available in black nylon, polypropylene, and Kynar®, a chemically resistant plastic. All kit components are also sold separately; see our website or CD-ROM catalog for a complete listing of kit components.


BS4 72-1416 Large Kit

Barbed Connector Kits

Catalog No.	$	Material	Kit Size	Tube ID Range
BS4 72-1409		Nylon	Small	1/16, 3/32 and 1/8 in
BS4 72-1410		Polypropylene	Small	1/16, 3/32 and 1/8 in
BS4 72-1411		Kynar®	Small	1/16, 3/32 and 1/8 in
BS4 72-1412		Nylon	Medium	1/4, 5/16 and 3/8 in
BS4 72-1413		Polypropylene	Medium	1/4, 5/16 and 3/8 in
BS4 72-1414		Kynar®	Medium	1/4, 5/16 and 3/8 in
BS4 72-1415		Nylon	Large	1/2 and 5/8 in
BS4 72-1416		Polypropylene	Large	1/2 and 5/8 in
BS4 72-1417		Kynar®	Large	1/2 and 5/8 in

Luer to Tube Kits


BS4 72-1406 Luer Connector Kit, White Nylon

Two kit styles are available. The Luer connection kits contain a selection of Luer fittings to interconnect luer connectors (e.g. syringes, stopcocks and needles) with one another and with tubing. These kits are available in white nylon (WN), polypropylene (PP) and Kynar® (KY - a chemically resistant autoclavable plastic). Fittings include: Luer to Barb, Male Luer Lock (MLL) and Female Luer Lock (FLL) to barbed connector (barb sizes: 1/16, 3/32, 1/8, 5/32, 3/16, 1/4 inch ID). Luer to Luer Connectors: MLT (Male Luer Taper) to MLT, RMLL (Rotating Male Luer Lock) to RMLL, FLL to FLL, FLL to FLL elbow, 3 x FLL 'T' connector, FLL to MLT and both MLL and FLL caps. Each kit is supplied in a convenient box. All kit components are also sold separately with convenient bin reorder part numbers located inside each kit lid. The Male Luer Taper kit contains various MLT fittings to barbed connectors as well as MLT to MLT fittings. The kit also contains color coded rotating luer lock rings that securely snap onto the MLT side of each connector.

Catalog No.	$	Product
Luer Connector Kit		
BS4 72-1406		White Nylon Luer Connector Kit
BS4 72-1407		Polypropylene Luer Connector Kit
BS4 72-1408		Kynar Luer Connector Kit
Male Luer Taper Kit		
BS4 72-2738		White Nylon Male Luer Taper Kit
BS4 72-2739		Polypropylene Male Luer Taper Kit
BS4 72-2740		Polycarbonate Male Luer Taper Kit

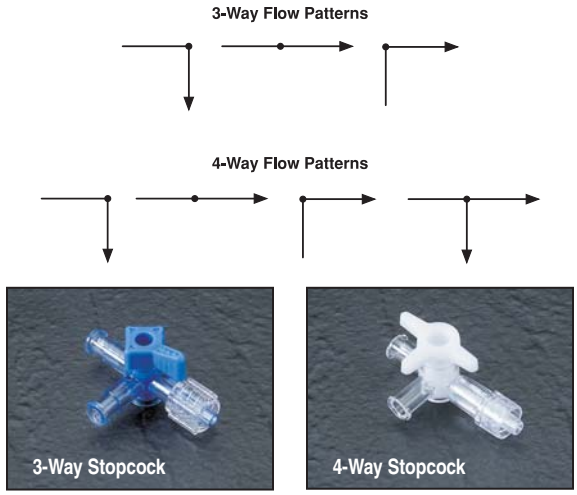
Tubing Manifold Kit

This kit contains several varieties of tubing manifolds for tube to tube connections. Many are compatible with MLT (male luer taper) fittings. Kit components are also sold individually.

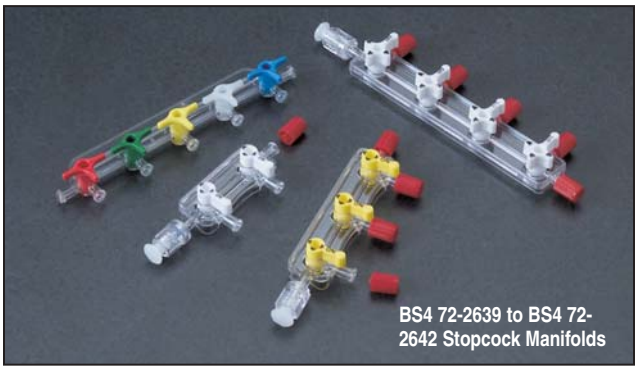
Catalog No.	$	Product
BS4 72-1665		Tubing Manifold Kit

Note: Photo does not represent final kit components. Please visit our website or contact our customer service department for full kit components listing.

Luer stopcocks allow the interconnection of syringes and tubing or equipment and provide control over flow patterns. Stopcocks are available in one of three flow control styles. 1-way stopcocks have two connections (inlet and outlet) and allow variable control of flow through the valve. 3-way and 4-way stopcocks have three fittings (inlet, outlet and side port). 3-way stopcocks have valve handles which rotate 270°. The 3-way valve handle is used to direct flow between any two ports (inlet to outlet, inlet to side port or side port to outlet). 4-way stopcocks have valve handles which rotate 360° and can direct flow between two ports, but also have a setting for interconnection of all three ports.



Stopcock Manifolds


BS4 72-2639 to BS4 72-2642 Stopcock Manifolds

These manifolds provide a simple and reliable means of interfacing multiple fluid or gas lines together using luer fittings. All side ports are FLL (female luer lock).

Catalog No.	$	Product
BS4 72-2639		Two Stopcock Manifold, 3-Way, RMLL* to FLL, pkg. of 2
BS4 72-2640		Three Stopcock Manifold, 3-Way, RMLL* to FLL, pkg. of 2
BS4 72-2641		Four Stopcock Manifold, 3-Way, RMLL* to FLL, pkg. of 2
BS4 72-2642		Five Stopcock Manifold, 4-Way, all FLL, pkg. of 2

**Note: RMLL (Rotating Male Luer Lock)*

Sterile Stopcocks

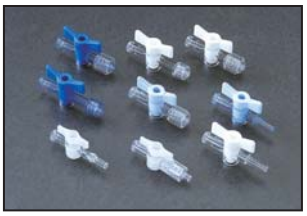
- Low torque, smooth turning construction
- Unique threaded female luer connection
- 1-, 3-, and 4-way stopcocks
- Available with extension tube sets

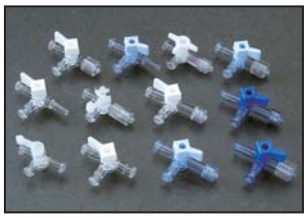
Stopcocks provide safe and simple interconnection of your tubing and syringe lines no matter what the application. Whether it is complex control of fluid infusions from a syringe or interconnection of pressure transducers and fluid injections lines in an isolated heart preparation, we have a wide selection of luer stopcocks to suit virtually every need. These stopcocks are available in 1-, 3-, and 4-way valve styles and come with or without extension tube sets. Each product found in the list below is sterile packaged individually and supplied in a box of 50.

Catalog No.	$	Product
BS4 72-2626		MLL to FLL stopcock, with Port Covers
BS4 72-2627		FLL to MLT stopcock, with Port Covers
BS4 72-2628		Multipath* stopcock, 2 x FLT, Injection Site, 20 inch Ext. Tube
BS4 72-2629		Multipath* stopcock, 2 x FLT, Injection Site, 33 inch Ext. Tube
BS4 72-2630		3-Way stopcock, FLL to MLT, No Port Covers
BS4 72-2631		3-Way stopcock, FLL to MLT with Port Covers
BS4 72-2632		3-Way stopcock FLL to 20 inch Ext. Tube Set
BS4 72-2633		3-Way stopcock FLL to 33 inch Ext. Tube Set
BS4 72-2634		Double 3-Way stopcock, FLL to MLL with Port Covers
BS4 72-2635		3-Way, FLL to MLL with Port Covers
BS4 72-2636		4-Way, FLL to MLT with Port Covers
BS4 72-2637		4-Way, FLL to 20 inch Ext. Tube Set
BS4 72-2638		4-Way, FLL to MLL with Port Covers

Abbreviations: MLT (Male Luer Taper); FLT (Female Luer Taper); FLL (Female Luer Lock); MLL (Male Luer Lock)
Note: All 3-Way and 4-Way Stopcocks feature FLL side ports. All extension tubes terminate in a MLT fitting with port cover.
**Special 3-Way valve, rotating valve selects side port for infusion.*

Luer Stopcock Kit





This kit includes a collection of 1-, 3- and 4-way stopcocks. Fittings include MLL (male luer lock), FLL (female luer lock), MLT (male luer taper) and barbed tubing connectors. Some stopcocks have high pressure capabilities. This kit is supplied in a convenient box. Kit components are also sold individually.

Catalog No.	$	Product
BS4 72-1664		Luer Stopcock Kit

Note: Both photos do not represent final kit components. Please visit our website or contact Harvard Apparatus customer service for the full kit component listing.

Spring-Clip Stopcocks

- Made from chrome-plated brass
- Unique spring-clip holds key in position
- Easy interface with other luer fittings

Spring-Clip Stopcocks				
Cat. No.	$	B-D Spring Clip Equiv. No.	Type	Description
BS4 59-8121		3138	3-Way	FLL to MLT, right side - FLL
BS4 59-8122		3161	3-Way	FLL to MLT, right side - hose barb[3]
BS4 59-8123		3150	3-Way	FLL to MLL, right side - hose barb[3]
BS4 59-8124		3156	3-Way	FLL to MLL, right side - FLL
BS4 59-8125[1]		3192	3-Way	FLL to MLT, left side - FLL
BS4 59-8126[2]		3135	1-Way	FLL to MLT
BS4 59-8127[1]		3152	1-Way	FLL to MLL

[1] *Product not pictured*
[2] *FLL (Female Luer Lock); MLT (Male Luer Taper)*
[3] *Barb size from 3.2 to 9.5 mm*

Tubing Clamp Kits

These clamps feature a simple-to-use ratcheting design which provides positive and secure clamping of tubing to barbed and non-barbed connectors. Thirteen different clamps provide clamping for tubing sizes from 1/16 inch OD to 1.5 inches OD. Supplied as package of 10 each of thirteen clamp sizes. Kit components are also sold individually.

Catalog No.	$	Product
BS4 72-1668		Tubing Clamp Kit

Flow Control Pinch Valves

These variable tubing clamps work with tubing with OD of 5/32 to 1/2 inch. The micrometer dial offers easy resetting of clamping distance. Made of Delrin®.

Cat. No.	$	Clamp Size	Tubing Clamp Range
BS4 72-2643		Small	5/32 to 1/4 in
BS4 72-2644		Medium	5/16 to 3/8 in
BS4 72-2645		Large	7/16 to 1/2 in

STEPDOS Liquid Metering Diaphragm Pump

- Diaphragm pumps which can be used to meter, dose, and transfer liquids
- Suitable for either corrosive or non-corrosive liquids
- Diaphragm design means there is no tubing to fatigue or break due to wear or corrosion
- Contamination-free operation
- Self-priming
- Can run dry indefinitely, without damage

A convenient way to meter, dose, transfer liquids or fill containers in the laboratory, the STEPDOS is resistant to chemical attack, prevents contamination of your pumped medium, and provides the longest possible lifetime when pumping corrosive liquids, gases and vapors. This new microprocessor-controlled metering diaphragm pump is designed for use with neutral and aggressive liquids, without the tubing maintenance disadvantages inherent in peristaltic pumps.

Unlike traditional pumps, there are neither metal wetted parts to corrode nor tubing to break or fatigue. These pumps are self-priming, maintenance free and will operate dry indefinitely without damage to the pumping mechanism. When operating, you have a choice of languages and the unit is easily programmed. The unique, single-piece molded diaphragm is designed to fit tightly against the pump head, eliminating dead space. The advanced valve design is capable of accurately handling low flow rates, and is not influenced by system pressure fluctuations or tubing fatigue. The multipurpose STEPDOS metering pump features microprocessor-control for exceptional flexibility and is protected by a case designed to withstand the harshest lab environments.

Unlike other diaphragm pumps on the market today, the STEPDOS has a remarkably smooth flow. This continuous and steady flow, even at low rpm, is accomplished by using a stepper motor that ensures that the suction cycle is completed at a maximum speed, but the output cycle is variably controlled per selected speed. Constant speed changes by the motor and electronic control provide steady output over the entire cycle.

Two basic control packages are available for the STEPDOS. For basic keypad control, choose the S model, which provides easy control of functions using the local touch pad. If you are looking for a more versatile pump, the 'RC' model allows you to control the pump remotely using your computer as well as basic keypad control. The 'RC' model is supplied with all cables and Windows™ 95 software to allow complete remote control and monitoring of a variety of operating parameters of the pump's rate from your personal computer.

You also have a choice of chemical resistance. For metering of neutral or mildly aggressive liquids, choose the standard version, which has a combination of wetted materials including PP, FFPM, and PTFE. If highly corrosive liquids are to be metered, the premium version provides the highest corrosion-resistance available in a pump today (wetted materials are a combination of PVDF, FFPM, and PTFE).

Specifications

Flow Range	0.08 to 80 ml/min
Max Pressure Head	30 p.s.i.
Motor Type	Bipolar stepper
Accuracy	±2%
Repeatability	±2%
Power Range	100 to 230 VAC, 50/60 Hz
Dimensions, H x W x D	8.0 x 11.5 x 18.0 cm (3.1 x 4.5 x 7.1 in)
Weight	1.4 kg (3 lb)
Tubing Connections	1/4 - 28 UNF Female Thread
CE Mark	EN 61010/EN 55011
Barbed Connections	1/16 - 3/16 in barb to 1/4 - 28 UNF Male

Cat No.	$	Product
BS4 72-0075		STEPDOS Liquid Metering Diaphragm Pump S Model, Standard Version
BS4 72-0076		STEPDOS Liquid Metering Diaphragm Pump S Model, Premium Version
BS4 72-0077		STEPDOS Liquid Metering Diaphragm Pump RC Model, Standard Version
BS4 72-0078		STEPDOS Liquid Metering Diaphragm Pump RC Model, Premium Version
BS4 72-1669		Threaded Barbed Fittings, five pairs of threaded fittings (1/4-28 UNF Mode) with barb sizes: 1/16, 3/32, 1/5, 5/32 and 3/16 inch

How to Calculate The Pressure Requirement of Your Experiment

The following chart will help you determine the pressure requirement of your experiment. This is important in selecting the correct pump with the proper psi capability for your application. Choose the selections that are the closest to your experimental conditions or write in your actual values. Once you have filled in the chart call us for technical assistance if needed.

1. Nature of the sample you are flowing into (Application)
2. The flow rate of the liquid
3. The surface area of the syringe and the linear force capability of the pump
4. The tubing diameter
5. The tubing length
6. Viscosity of the fluid being pumped
7. The temperature of the fluid being pumped

		NORMAL PRESSURE 0 to 30 psi (0 to 2 bar)	HIGH FORCE 31 to 150 psi (2.1 to 10.2 bar)	XTREME HIGH PRESSURE 151 to 2000 psi (10.3 to 137 bar)
1	**APPLICATION**			
LOW	Flow into open containers i.e. titrations, food trays filling	●		
LOW	Inject into Tissue i.e. Drug infusion into muscle, brain	●		
HIGH	Flow into closed container, i.e. Reaction Chamber 350 to 400 psi	●	●	
HIGH	Highly viscose solutions at high flow rates in a short period of time, i.e. Corn syrup	●	●	●
2	**FLOW RATE - Pumping Speed (The faster the flow rate, the higher the pressure)**			
	0.003 µl/hr to 140 ml/min	●	●	
	141 ml/min to 220 ml/min	●	●	●
3	**SYRINGE SIZE (Syringe volume/plunger area + linear force of pump)**			
	10 µl to 1 ml ie. 500 µl/min x 20 Lbs = 500	●	●	
4	**TUBING SIZE (Inner diameter, Smaller ID = higher pressure)**			
	Small - capillary (the longer more pressure)	●	●	●
	Large - Hose	●	●	
5	**TUBING LENGTH - DISTANCE (Depends on ID Smaller ID = higher pressure)**			
	Short, < 1M	●		
	Long, > 1M	●	●	●
6	**VISCOSITY OF MATERIAL TO BE PUMPED (Higher viscosity = higher pressure)**			
	Air 18˚C = 0.0182 cP	●		
	Water 20˚C = 1.002 cP	●	●	●
	Olive Oil 20˚C = 84 cP	●	●	●
	Pancake Syrup 20˚C = 2500 cP	●	●	●
	Honey 20˚C = 10000 cP	●	●	●
	Peanut Butter 20˚C = 250000 cP	●	●	●
7	**TEMPERATURE OF SOLUTIONS BEING PUMPED (Higher temperature = lower viscosity = lower pressure)**			
	0 to 15˚C		●	●
	15 to 80˚C	●	●	●

Syringe Pump Pressure and Flow Rate

How to Calculate the Pressure of Various Syringe Sizes

The pressure that a syringe pump can generate is a function of both the force of the pump (measured at the pusher block in pounds) as well as the physical characteristics of the syringe and setup used. The following table compares various syringe pumps and the pressures in PSI (pounds per square inch). Each data point was calculated by dividing the average pump force by the surface area (in square inches) of syringes with diameters from 0.1 to 50 mm. Diameters for a variety of syringes can be found in the table on page A96. This table is intended to be a guide of total pressures generated. Actual values may be higher or lower than the listed pressures due to the influence of other factors such as tubing diameter and length. When using more than one syringe sharing the same pusher block, the pressure is calculated by dividing the force (lbs) by the total surface area (square inches) of all syringes on the pump. For example, nominal pressure obtained using two 25 ml Hamilton Gastight® syringes on a PHD 22/2000 standard pressure syringe pump would be: 50 lbs / (0.644 in^2 X 2) = 38.81 PSI (2.68 bars).

Pump Average Pressure[A] (PSI)[B]								
Syringe Size	Syringe Dia (mm)	Pump 11 Plus	Pump 11 Pico Plus	Pump 22	Pump 33	PHD 22/2000	PHD 22/2000 Hpsi	PHD 4400 Hpsi
0.5 µl	0.1	>1000	>1000	>1000	>1000	>1000	–	>1000
10 µl	0.5	>1000	>1000	>1000	>1000	>1000	–	>1000
50 µl	1	>1000	>1000	>1000	>1000	>1000	–	>1000
1 ml	5	526	821	>1000	>1000	>1000	–	>1000
5 ml	10	131	205	386	468	394	–	1438
10 ml	15	58	91	172	208	175	–	639
50 ml	25	21	33	62	75	63	569	230
Force (lbs)		16	25[C]	47	57	48	433	200
see page		A8	A9	A10	A11	A12	A16	A18

A. Calculated pressure based on pump force at average speed
- *Higher pressures may be achieved at minimum speed and lower pressures at maximum speed.*
- *Pump speed and force are inversely proportional.*
- *Most syringes are pressure rated and may not be able to tolerate pressure generated by the syringe pump. Consult Harvard Apparatus or your syringe manufacturer for syringe details and specifications.*

B. To convert pressure from PSI to bars use the following equation: bar pressure = PSI x 0.0690.

C. Actual force is higher. Use of pump with greater back pressure may result in premature wear of syringe pump halfnut.

Minimum/Maximum Flow Rates By Pump and Syringe Size

Flow rates were calculated based on the pusher block travel rate for each pump (rate at which the syringe pump moves the syringe plunger) and the diameter of the syringe.

Pump 11 Pico Plus Flow Rates			
Syringe Size	Nominal Diameter, mm*	Minimum	Maximum
0.5 µl	0.10	1.3 pl/min	20.00 nl/min
1 µl	0.15	3.0 pl/min	46.00 nl/min
10 µl	0.46	27.0 pl/min	400.00 nl/min
100 µl	1.46	270.0 pl/min	0.004 ml/min
1000 µl	4.61	2,690.0 pl/min	0.043 ml/min
10 ml	14.57	27.0 nl/min	0.439 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page A96.*

Minimum/Maximum Flow Rates By Pump and Syringe Size (Cont.)

Pump 11 Plus Flow Rates

Syringe Size	Diameter, mm*	µl/hr Min to Max	µl/min Min to Max	ml/hr Min to Max	ml/min Min to Max
0.5 µl	0.10	0.0014 to 22.35	0.0001 to 0.3725	0.0001 to 0.0223	0.0001 to 0.0003
1 µl	0.15	0.0031 to 50.29	0.0001 to 0.8383	0.0001 to 0.0502	0.0001 to 0.0008
2 µl	0.21	0.0061 to 98.58	0.0002 to 1.6430	0.0001 to 0.0985	0.0001 to .0016
5 µl	0.33	0.0149 to 243.4	0.0003 to 4.057	0.0001 to 0.2434	0.0001 to 0.0040
10 µl	0.46	0.0289 to 473.0	0.0005 to 7.883	0.0001 to 0.4730	0.0001 to 0.0078
25 µl	0.73	0.0728 to 1191	0.0013 to 19.85	0.0001 to 1.191	0.0001 to 0.0198
50 µl	1.03	0.1448 to 2371	0.0025 to 39.52	0.0002 to 2.371	0.0001 to 0.0395
100 µl	1.46	0.2909 to 4765	0.0049 to 79.41	0.0003 to 4.765	0.0001 to 0.0794
250 µl	2.30	0.7218 to 9999	0.0121 to 197.0	0.0008 to 11.82	0.0001 to 0.1970
1000 µl	4.61	1.451 to 9999	0.0242 to 395.7	0.0015 to 23.75	0.0001 to 0.3959
1 ml	5.00	2.900 to 9999	0.0484 to 791.8	0.0029 to 47.50	0.0001 to 0.7918
2.5 ml	7.28 to 9.6	7.232 to 9999	0.1206 to 1974	0.0073 to 118.4	0.0002 to 1.974
3 ml	8.66 to 9.0	10.24 to 9999	0.1706 to 2794	0.0103 to 167.6	0.0002 to 2.794
5 ml	10.3 to 13.0	14.50 to 9999	0.2413 to 3952	0.0145 to 237.1	0.0003 to 3.952
10 ml	14.57 to 15.9	28.97 to 9999	0.4828 to 7909	0.0290 to 474.5	0.0005 to 7.909
20 ml	19.13 to 20.05	54.86 to 9999	0.9142 to 9999	0.0549 to 898.6	0.0010 to 14.97
30 ml	21.7 to 23.2	72.81 to 9999	1.214 to 9999	0.0729 to 1192	0.00013 to 19.88
50 ml	26.7 to 32.6	97.27 to 9999	1.622 to 9999	0.0973 to 1576	0.0017 to 26.56

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page A96.*

Pump 22 Flow Rates

Syringe Size	Diameter, mm*	µl/hr Min to Max	µl/min Min to Max	ml/hr Min to Max	ml/min Min to Max
0.5 µl	0.10	0.002 to 23.8	–	–	–
1 µl	0.15	0.003 to 47.8	–	–	–
2 µl	0.21	0.006 to 95.2	–	–	–
5 µl	0.33	0.015 to 238.0	–	–	–
10 µl	0.46	0.029 to 474.0	–	–	–
25 µl	0.73	0.073 to 1193.0	–	–	–
50 µl	1.03	–	0.002 to 39.7	–	–
100 µl	1.46	–	0.005 to 79.7	–	–
250 µl	2.30	–	0.012 to 197.8	–	–
500 µl	3.26	–	0.024 to 397.0	–	–
1000 µl	4.61	–	0.048 to 795.0	–	–
1 ml	5.00	–	0.049 to 805.0	–	–
2 ml	9.00	–	–	0.011 to 186.6	–
2.5 ml	7.28 to 9.6	–	–	0.10 to 168.2	–
3 ml	8.66 to 9.0	–	–	0.011 to 181.4	–
5 ml	10.3 to 13.0	–	–	0.019 to 317.0	–
10 ml	14.57 to 15.9	–	–	0.028 to 461.0	–
20 ml	19.13 to 20.05	–	–	0.050 to 821.0	–
30 ml	21.7 to 23.2	–	–	0.074 to 1208.8	–
50 ml	26.7 to 32.6	–	–	–	0.002 to 28.4
100 ml	34.9 to 35.7	–	–	–	0.003 to 47.6
140 ml	38.40	–	–	–	0.004 to 55.1

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page A96.*

Minimum/Maximum Flow Rates By Pump and Syringe Size (Cont.)

Pump 33 Flow Rates

Syringe Size	Diameter, mm*	µl/hr Min	µl/min Max	ml/hr Max	ml/min Max
0.5 µl	0.10	–	–	–	–
1 µl	0.15	–	–	–	–
2 µl	0.21	–	–	–	–
5 µl	0.33	–	–	–	–
10 µl	0.46	0.0073	950.05	–	–
25 µl	0.73	0.0183	2386.10	–	–
50 µl	1.03	0.0365	4772.50	–	–
100 µl	1.46	0.0731	9570.50	–	–
250 µl	2.30	0.1813	–	23.751	–
500 µl	3.26	–	–	–	–
1000 µl	4.61	0.7281	–	95.418	–
1 ml	5.00	0.7828	–	102.580	–
2 ml	9.00	2.8493	–	373.430	–
2.5 ml	7.28 to 9.6	1.8156	–	237.950	–
3 ml	8.66 to 9.0	2.5691	–	336.710	–
5 ml	10.3 to 13.0	4.9824	–	653.010	–
10 ml	14.57 to 15.9	7.2024	–	–	15.733
20 ml	19.13 to 20.05	12.536	–	–	27.384
30 ml	21.7 to 23.2	16.131	–	–	35.236
50 ml	26.7 to 32.6	24.4201	–	–	53.346
100 ml	34.9 to 35.7	–	–	–	–
140 ml	38.40	–	–	–	–

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page A96.*

PHD 22/2000, PHD 22/2000 Hpsi and PHD 4400 Hpsi Flow Rates

Syringe Size	Diameter, mm*	µl/hr Min to Max	µl/min Min	ml/hr Max	ml/min Max
0.5 µl	0.10	0.0001 to 95.330	–	–	–
1 µl	0.15	0.0002 to 190.70	–	–	–
2 µl	0.21	0.0004 to 381.30	–	–	–
5 µl	0.33	0.0010 to 953.17	–	–	–
10 µl	0.46	0.0019	–	1.901	–
25 µl	0.73	0.0046	–	4.775	–
50 µl	1.03	0.0092	–	9.551	–
100 µl	1.46	0.0183	–	19.153	–
250 µl	2.30	0.0454	–	47.532	–
500 µl	3.26	0.0911	–	95.492	–
1000 µl	4.61	–	0.0031	190.950	–
1 ml	5.00	–	0.0033	205.30	–
2 ml	9.00	–	0.0119	747.35	–
2.5 ml	7.28 to 9.6	–	0.0076	476.21	–
3 ml	8.66 to 9.0	–	0.0100	–	11.231
5 ml	10.3 to 13.0	–	0.0208	–	21.781
10 ml	14.57 to 15.9	–	0.0301	–	31.486
20 ml	19.13 to 20.05	–	0.0523	–	54.804
30 ml	21.7 to 23.2	–	0.0673	–	70.518
50 ml	26.7 to 32.6	–	0.1019	–	106.76
100 ml	34.9 to 35.7	–	0.1740	–	182.40
140 ml	38.40	–	0.2106	–	220.82

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page A96.*

Common Syringe Data - Diameter and Plunger Surface Area

The following list is a guide to common syringes and their associated diameters and surface area. Syringe diameter data, in mm, is listed below for each syringe. All Harvard Apparatus microprocessor syringe pumps require the user to input syringe diameter information. The pump uses this diameter data to set flow rates. The PHD 22/2000 series of syringe pumps also has this information built into the pump memory in a handy Syringe Look Up Table. Surface area information was used to calculate PSI (pounds per square inch) data for the pressure table on page A93. Average pressures for any syringe pump and syringe combination can be calculated by dividing the average (nominal) syringe pump force by the syringe diameter (in square inches) to obtain PSI. Example, nominal pressure obtained using a 25 ml Hamilton Gastight® syringe on a PHD 22/2000 standard pressure syringe pump would be: 50 lbs / 0.644 in^2 = 77.6 PSI (5.35 bars).

Common Syringes and Their Diameters

Volume	Dia. (mm)	Area (in2)
BD Plastic		
1 ml	4.78	0.027815
3 ml	8.66	0.091297
5 ml	12.06	0.177059
10 ml	14.5	0.255952
20 ml	19.13	0.445505
30 ml	21.7	0.573247
50/60 ml	26.7	0.867851
BD Glass		
0.5 ml	4.64	0.026209
1 ml	4.64	0.026209
2.5 ml	8.66	0.091297
5 ml	11.86	0.171235
10 ml	14.34	0.250335
20 ml	19.13	0.445505
30 ml	22.7	0.627298
50 ml	28.6	0.995760
100 ml	34.9	1.482768
SGE Glass		
25 µl	0.73	0.000649
50 µl	1.03	0.001292
100 µl	1.46	0.002595
250 µl	2.3	0.006440
500 µl	3.26	0.012938
1 ml	4.61	0.025872
2.5 ml	7.28	0.064519
5 ml	10.3	0.129151
10 ml	14.57	0.258429
Harvard Stainless Steel		
8 ml	9.525	0.110447
20 ml	19.13	0.445505
50 ml	28.6	0.995760
100 ml	34.9	1.482768
200 ml	44.75	2.438382

Volume	Dia. (mm)	Area (in2)
Ranfac Glass		
2 ml	9.12	0.101254
5 ml	12.34	0.185376
10 ml	14.55	0.257720
20 ml	19.86	0.480154
30 ml	23.2	0.655237
50 ml	27.6	0.927343
Terumo Plastic		
3 ml	8.95	0.097514
5 ml	13	0.205735
10 ml	15.8	0.303904
20 ml	20.15	0.494279
30 ml	23.1	0.649601
60 ml	29.1	1.030881
Air-Tite All Plastic		
2.5 ml	9.6	0.112193
5 ml	12.45	0.188695
10 ml	15.9	0.307763
20 ml	20.05	0.489386
30 ml	22.5	0.616293
50 ml	29	1.023808
Popper & Sons Perfectum Glass		
0.5 ml	3.45	0.014490
1 ml	4.5	0.024652
2 ml	8.92	0.096862
3 ml	8.99	0.098388
5 ml	11.7	0.166646
10 ml	14.7	0.263061
20 ml	19.58	0.466711
30 ml	22.7	0.627298
50 ml	29	1.023808
100 ml	35.7	1.551525

Volume	Dia. (mm)	Area (in2)
Hamilton Gastight Glass		
0.5 µl	0.103	0.000013
1 µl	0.1457	0.000026
2 µl	0.206	0.000052
5 µl	0.3257	0.000129
10 µl	0.46	0.000258
25 µl	0.729	0.000647
50 µl	1.031	0.001294
100 µl	1.46	0.002595
250 µl	2.3	0.006440
500 µl	3.26	0.012938
1000 µl	4.61	0.025872
2.5 ml	7.28	0.064519
5 ml	10.3	0.129151
10 ml	14.57	0.258429
25 ml	23	0.643989
50 ml	32.6	1.293772
Unimetrics - 4000 and 5000 Glass		
10 µl	0.46	0.000258
25 µl	0.729	0.000647
50 µl	1.031	0.001294
100 µl	1.46	0.002595
250 µl	2.3	0.006440
500 µl	3.26	0.012938
1000 µl	4.61	0.025872
Kendall Monoject Plastic		
1 ml	4.65	0.026323
3 ml	8.94	0.097297
6 ml	12.7	0.196350
12 ml	15.9	0.307763
20 ml	20.4	0.506621
35 ml	23.8	0.689567
60 ml	26.6	0.861362
140 ml	38.4	1.795084

How to Select the Correct Syringe for Your Application

Syringe Type/Size	Swage Lock	Luer Lock	RN	Threaded 1/4• 28	Leur Slip Fit	Pressure Maximum p.s.i.	Compatibility with Substance in Syringe	Accuracy 1%	Accuracy 5%	Materials
Stainless Steel Syringes, see page A70										
8 ml	•					1,500	Maximum	•		316 / Chemraz
20 ml	•	•				750	Maximum	•		316 / Viton or Chemraz
50 ml	•	•				750	Maximum	•		316 / Viton or Chemraz
100 ml	•	•				750	Maximum	•		316 / Viton or Chemraz
200 ml	•	•				750	Maximum	•		316 / Viton or Chemraz
Glass GasTight Syringes, see pages A73 and A74										
1 to 100 µl		•	•	•	•	1,000	Maximum	•		Glass and Teflon
250 to 500 µl		•	•	•	•	500	Maximum	•		Glass and Teflon
1 to 10 ml		•	•	•		200	Maximum	•		Glass and Teflon
25 to 100 ml		•	•	•		100	Maximum	•		Glass and Teflon
Glass Multifit Syringes, see page A75										
2 to 50 ml		•				100	Maximum	•		Glass Only
Plastic Syringes, see pages A76 to A77										
1 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
5 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
10 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
20 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
30 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
50/60 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
140 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber

Needle Cross Reference Chart

French Scale and Needle Gauge Cross Reference Chart								
	Exact French OD			Exact Gauge OD		Exact Gauge ID		Volume
French Scale*	in	mm	Needle Gauge	in	mm	in	mm	µl/in
-	0.0083	0.21	33	0.0083	0.21	0.0040	0.11	0.20
-	0.0093	0.24	32	0.0093	0.24	0.0043	0.11	0.20
-	0.0103	0.26	31	0.0103	0.26	0.0053	0.13	0.34
-	0.0123	0.31	30	0.0123	0.31	0.0063	0.16	0.45
1	0.013	0.33	29	0.013	0.33	-	-	-
-	0.014	0.36	28	0.014	0.36	0.0073	0.18	0.63
-	0.016	0.41	27	0.016	0.41	0.0083	0.21	0.80
-	0.018	0.46	26	0.018	0.46	0.0103	0.26	1.25
1.8	0.024	0.61	25	0.023	0.51	0.0103	0.26	1.25
-	0.022	0.57	24	0.022	0.57	0.0123	0.31	1.80
2	0.026	0.66	23	0.025	0.64	0.0133	0.34	2.17
-	0.028	0.72	22	0.028	0.72	0.0163	0.41	3.35
2.4	0.031	0.79	21	0.032	0.82	0.0203	0.51	5.19
2.9	0.038	0.97	20	0.036	0.91	0.0238	0.60	6.71
3	0.039	0.99	-	0.039	0.99	-	-	-
3.3	0.043	1.09	19	0.042	1.07	0.0270	0.69	-
3.7	0.048	1.22	-	0.048	1.22	-	-	-
3.8	0.050	1.27	18	0.050	1.27	0.0330	0.84	14.08
4	0.052	1.32	-	0.052	1.32	-	-	-
4.6	0.060	1.52	17	0.058	1.47	0.0420	1.07	22.84
4.7	0.062	1.57	-	0.062	1.57	-	-	-
5	0.066	1.68	16	0.065	1.65	0.0470	1.19	28.25
5.1	0.067	1.70	-	0.067	1.70	-	-	-
5.7	0.075	1.91	15	0.072	1.83	0.0540	1.37	-
5.9	0.078	1.98	-	0.078	1.98	-	-	-
6	0.079	2.01	-	0.079	2.01	-	-	-
6.2	0.082	2.08	14	0.083	2.11	0.0630	1.60	51.07
7	0.092	2.34	-	0.092	2.34	-	-	-
7.2	0.095	2.41	13	0.095	2.41	0.0710	1.80	64.63
8	0.105	2.67	-	0.105	2.67	-	-	-
8.1	0.106	2.69	-	0.106	2.69	-	-	-
-	0.109	2.77	12	0.109	2.77	0.0850	2.16	93.07
8.4	0.118	3.00	11	0.120	3.05	0.0940	2.39	113.00
9.8	0.128	3.25	-	0.128	3.25	-	-	-
10	0.131	3.33	10	0.134	3.40	0.1060	2.69	143.28
11	0.145	3.68	-	0.145	3.68	-	-	-
11.7	0.153	3.89	-	0.153	3.89	-	-	-
12.3	0.161	4.09	-	0.161	4.09	-	-	-
13	0.171	4.34	-	0.171	4.34	-	-	-
14	0.184	4.67	-	0.184	4.67	-	-	-
15	0.197	5.00	-	0.197	5.00	-	-	-
16	0.210	5.33	-	0.210	5.33	-	-	-
17	0.223	5.66	-	0.223	5.66	-	-	-
18	0.236	5.99	-	0.236	5.99	-	-	-

** French Scale = OD (in) x 76.211 - 0.0014*

Pressure Cross Reference Chart

Pressure Unit Cross Reference Chart								
	atm	psi (lb/in_2)	cm H_2O (mmWS)	mm Hg (Torr)	kPa (kN/m_2)	inch H_2O	inch Hg	mbar
1 atm =	1	14.696	1030.104	760.000	101.325	2616.464	29.944	986.663
1 psi =	0.068	1	70.094	51.715	6.895	178.039	2.038	68.966
1 cm H_2O =	0.0010	0.0143	1	0.7377	0.0984	2.5400	0.0291	0.9578
1 mm Hg =	0.0013	0.0193	1.355	1	0.133	3.443	0.039	1.298
1 kPa =	0.145	2.131	10.200	7.525	1	4.021	0.296	143.066
1 inch H_2O =	0.433	6.363	445.984	329.042	43.869	1	12.964	427.176
1 inch Hg =	22.390	329.042	23063.927	17016.325	2268.657	58582.373	1	22091.293
1 mbar =	2.985	43.869	3074.937	2268.657	302.463	7810.341	89.385	1

Force Conversion Table

Conversion Table for Force Units		
mN	mg-force	mp
0.1	10	10.20
0.2	20	20.39
0.3	30	30.59
0.4	40	40.79
0.5	50	50.99
0.6	60	61.18
0.7	70	71.38
0.8	80	81.58
0.9	90	91.77
1	100	101.97
2	200	203.94
3	300	305.92
4	400	407.89
5	500	509.86
6	600	611.83
7	700	713.8
8	800	815.78
9	900	917.75

1N = 1 Newton = 1 kg m/s^2
1p = 1 Pond

HARVARD BIOSCIENCE

FAMILY OF COMPANIES

AREAS OF CONCENTRATION

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	HARVARD APPARATUS LTD/UK	Physiology Recorders, Amplifiers, Transducers, Surgical Tables & Blankets
	BTX HARVARD APPARATUS	The ultimate source for all your electroporation and electrofusion needs!
	AmKa	Dialysis & Affinity, Sample Preparation Products
	HEI	**Clark Electromedical** World Standard Capillary Glass
	HSE	**Hugo Sachs Elektronik** Isolated Organ & Tissue Systems, Data Acquisition
	IMS	**International Market Supply** Anesthesia & Animal Behavior
	Medical Systems Research Products	Micro-Injectors, Micro-Incubators, Brain Slice Chambers, Iontophoretic Pumps
	HARVARD NAVICYTE	Diffusion/Ussing Chambers, Substance Transport Studies
	WARNER INSTRUMENTS	Clamp Amplifiers & Systems, Micro-Perfusion Chambers, Ussing, Micro-Incubators, Cell Imaging
Biochrom Group	biochrom	Spectrophotometers & Amino Acid Analyzers
	ASYS HITECH	Microplate Readers, Washers & Dispensers
	Hoefer®	High quality electrophoresis, blotting, quantitation and detection systems and more.
	SCIE-PLAS	Full Range of Electrophoresis & Radiation Protection Products
	WPA	**Walden Precision Apparatus** pH Meters, Conductivity Meters, Colorimeters, Oxygen Meters, Spectrophotometers
Genomic Solutions Group	GENOMIC SOLUTIONS™	Genomic & Proteomic Research Tools for Complete Drug Discovery Solutions
	GENEMACHINES	DNA Purification, Oligo Synthesis, Colony Picking, Microarraying, DNA Shearing and Cell Growth
UBI Group	UNION BIOMETRICA	Model Organism Studies, HTS COPAS & Flow Cytometry