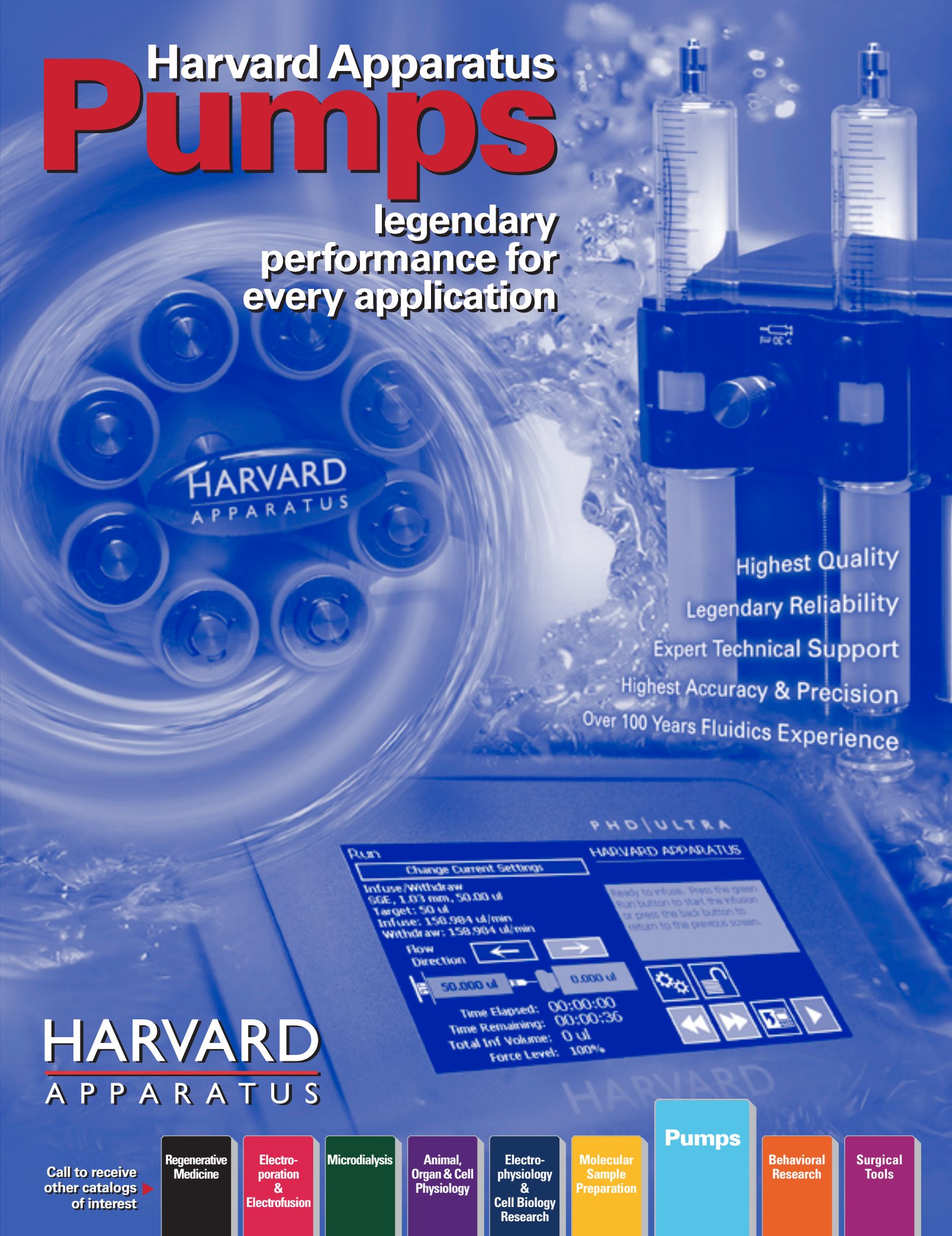
Harvard Apparatus Pumps

legendary performance for every application



HARVARD APPARATUS

Call to receive other catalogs of interest

Regenerative Medicine | Electroporation & Electrofusion | Microdialysis | Animal, Organ & Cell Physiology | Electrophysiology & Cell Biology Research | Molecular Sample Preparation | **Pumps** | Behavioral Research | Surgical Tools

NEW

Harvard Peristaltic Pump

Series of Peristaltic Pumps

- First Peristaltic Pump with a Touch Screen Controller
- Simple to Use
- Accurate Delivery ±1.0%
- Unmatched Versatility:
  - Pump Controller
  - Interchangeable Motor Pump Heads
- Widest Flow Rate Range in a Peristaltic Pump
  - P-70 - 0.001 to 70 ml/min
  - P-230 - 0.001 to 230 ml/min
  - P-1500 - 0.001 to 1,500 ml/min

Harvard Apparatus is known globally for creating the most advanced syringe pumps in the market. We are now excited to introduce the NEW Harvard Peristaltic Pump. This new Peristaltic Pump Series is built with the legendary quality and reliability that is synonymous with Harvard Apparatus. Its flexibility and accuracy opens up a wide range of new application areas for both new and existing Harvard Apparatus customers.

Please see page 62-63 for complete details.

PHD ULTRA™

Series of Syringe Pumps

The PHD ULTRA™ Series is the solution for your most demanding fluidics applications. We are proud to announce the newest member of the family, the NEW PHD ULTRA™ CP. This pump delivers fluid at constant pressure. The PHD™ ULTRA pumps have unmatched flow accuracy and precision. The new LCD color touch screen and intuitive icon interface provide unparalleled ease of use so you can easily program simple to complex methods without a PC.

Please see pages 16 to 25 for the entire PHD ULTRA™ family of pumps.

Pump 11 Elite

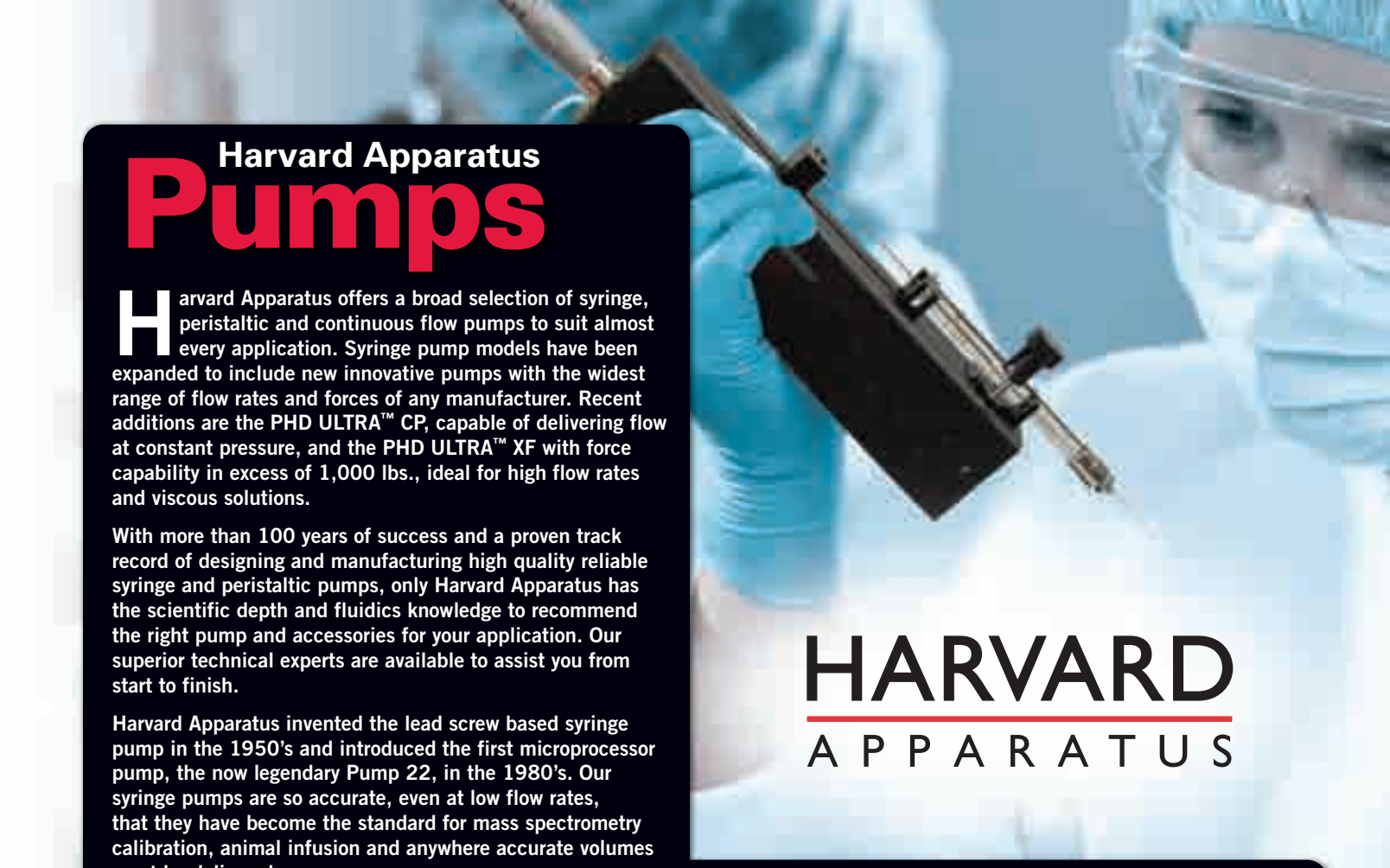
Series of Syringe Pumps

The Pump 11 Elite Series expands its capabilities to satisfy your experimental requirements. These compact syringe pumps carry on the tradition as the premier workhorse infusion pump. They offer outstanding flow performance and unparalleled ease of use with a high resolution color touch screen and intuitive icon interface. The Pump 11 Elite Series allows you to create simple to complex methods without a PC.

Please see page 11-15 for complete details.

HARVARD APPARATUS

Note: Products in this catalog are for Research Use Only. Not for use on humans unless proper investigational device regulations have been followed.



Harvard Apparatus Pumps

HARVARD APPARATUS

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. Recent additions are the PHD ULTRA™ CP, capable of delivering flow at constant pressure, and the PHD ULTRA™ XF with force capability in excess of 1,000 lbs., ideal for high flow rates and viscous solutions.

With more than 100 years of success and a proven track record of designing and manufacturing high quality reliable syringe and peristaltic pumps, only Harvard Apparatus has the scientific depth and fluidics knowledge to recommend the right pump and accessories for your application. Our superior technical experts are available to assist you from start to finish.

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, animal infusion and anywhere accurate volumes must be delivered.

Our PHD ULTRA™ and Pump 11 Elite Series have set a new standard in syringe pumps. They are easy to use with an intuitive interface controlled via touch screen. The PHD ULTRA™ and Pump 11 Elite are suitable for a wide range of applications including mass spec calibration, drug and nutritional studies, macro to micro reactors, LP chromatography, electrospinning, aerosols and macrofluidics to microfluidics. Running a syringe pump has never been easier.

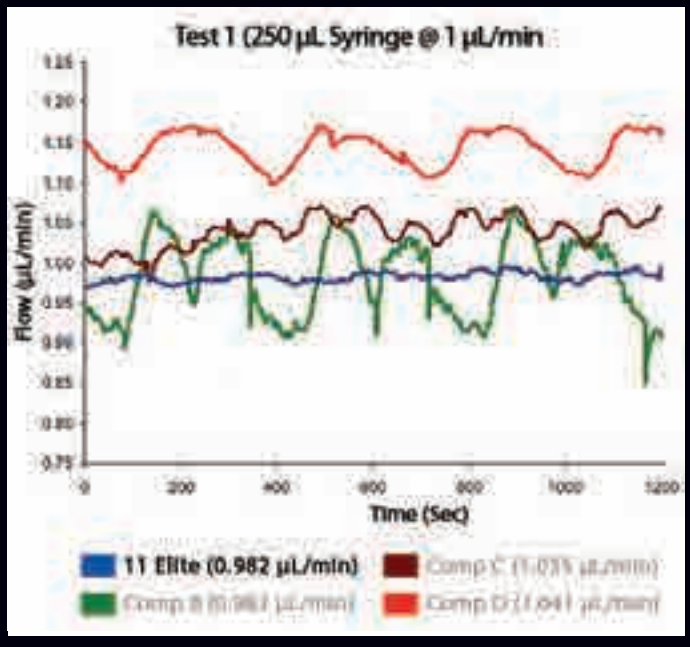
The Pump 11 Pico Plus Elite is best suited for low flow rate studies and small volume injections. It is ideal for applications including: microdialysis, animal drug and nutritional studies, cellular injection, and more.

The NEW Harvard Peristaltic Pumps provide digital control over a wide range of flow rates for applications including: dispensing/dilution, organ/tissue perfusion, and fluid circulation. Harvard Apparatus offers an expanded line of component pumping modules for OEM and specialized system development.

Results you can count on!

Since 2011, there have been more than 2,000 scientific publications referencing the use of Harvard Apparatus pumps in areas including: infusion, microfluidics, perfusion, electrospinning, and more. You can count on our expert technical support to provide product recommendations and application support to advance your studies.

If you don't find what you need, please contact us! Our technical support and engineering teams can assist in creating special pumps or custom pumping systems to meet your requirements.



Performance

All pumps are not created equal. The graph above shows the flow profiles of the Pump 11 Elite versus three similar specification competitors run under the same conditions. When volume accuracy and flow stability are important to your experiments, only Harvard Apparatus delivers.

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PERISTALTIC PUMP ACCESSORIES

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NEW Harvard Peristaltic Pump: Control Box and Pump options, page 62

BLOOD PUMPS

TUBING

CONNECTORS AND VALVES

PUMP REFERENCES

Choosing the Right Pump for Your Application & Budget

SYRINGE PUMP QUESTIONS

- What is your application?
- How many syringes will be used simultaneously?
- What size syringe will be used?
- What flow rate(s) will be used? See pump reference pages 114-123
- What is the total volume to be delivered?
- Does the pump need to withdraw (fill the syringe) as well as infuse (dispense)?

Syringe Pump Selection Guide

	INFUSION ONLY							
MODEL	**PUMP 11 ELITE**	**PUMP 22 ****	**PHD 22/2000**	**PHD ULTRA™**	**NANOCOOL™**	**PUMP 11 ELITE**	**PUMP 11 PICO PLUS ELITE**	**PUMP 11 ELITE NANOMITE**
SEE PAGE	11	30	33	18	28	11	14	15
STANDARD PUMP	**PC2 70-4500 PC2 70-4501**	**PC2 55-2222**	**PC2 70-2000**	**PC2 70-3005**	–	–	–	–
PROGRAMMABLE PUMP	–	–	–	–	**PC2 88-1050**	**PC2 70-4504 PC2 70-4505**	**PC2 70-4506**	**PC2 70-4507**
NUMBER OF SYRINGES	1 or 2	2 to 10*	2 to 10*	2 to 10*	1	1 or 2	2	1
MINIMUM SYRINGE SIZE	0.5 µl	0.5 µl	0.5 µl	0.5 µl	50 µl	0.5 µl	0.5 µl	0.5 µl
MAXIMUM SYRINGE SIZE	50/60 ml (single) 10 ml (dual)	140 ml	140 ml	140 ml	500 µl	50/60 ml (single) 10 ml (dual)	10 ml	1 ml
MINIMUM FLOW RATE	1.26 pl/min	0.002 µl/hr	0.0001 µl/hr	1.50 pl/min	3.66 pl/min	1.26 pl/min	0.54 pl/min	3.66 pl/min
MAXIMUM FLOW RATE	88.40 ml/min (single) 26.02 ml/min (dual)	55.1 ml/min	220.82 ml/min	216.0 ml/min	1.91 ml/min	88.40 ml/min (single) 26.02 ml/min (dual)	11.70 ml/min	3.82 ml/min
AVERAGE LINEAR FORCE	16 kg (35 lbs) (adjustable)	21 kg (47 lbs)	23 kg (50 lbs) or 30 kg (66 lbs)	34 kg (75 lbs) (adjustable)	–	16 kg (35 lbs) (adjustable)	16 kg (35 lbs) (adjustable)	5 kg (11 lbs) (adjustable)
COMPUTER CONTROL	USB	RS-232	RS-232	USB + RS-232	USB + RS-232	USB	USB	USB
I/O + TTL CONNECTION	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DIMENSIONS (H x W x D)	22.6 x 17.78 x 15 cm (9 x 7 x 6 in)	28 x 22.2 x 14 cm (11 x 8.75 x 5.5 in)	15.9 x 22.8 x 27.9 cm (6.3 x 9 x 11 in)	10.16 x 30.5 x 21.6 cm (4 x 12 x 8.5 in)	30.5 x 21.6 x 10.6 cm (12 x 8.5 x 4.3 in)	22.6 x 17.78 x 15 cm (9 x 7 x 6 in)	22.6 x 17.78 x 15 cm (9 x 7 x 6 in)	22.6 x 17.78 x 9.32 cm (9 x 7 x 3.67 in)
PUMP HEAD DIMENSIONS (H x W x D)	–	–	–	–	20.3 x 5.1 x 5.1 cm (8 x 2 x 2 in)	–	–	6.35 x 5.08 x 19.05 cm (2.5 x 2.0 x 7.5 in)
WEIGHT	2.1 kg (4.61 lbs)	4.5 kg (10 lbs)	4.5 kg (10 lbs)	4.5 kg (10 lbs)	4.5 kg (10 lbs)	2.1 kg (4.6 lbs)	2.1 kg (4.61 lbs)	1.96 kg (4.32 lbs)

Please contact Technical Support for assistance.

** Depends upon the Syringe Rack*

4 x 140 Syringe Rack	*Holds four 60 ml or 140 ml plastic syringes only*
6 x 10 Syringe Rack	*Holds six 30 to 60 ml syringes or ten 0.5 µl to 20 ml syringes*
Microliter Syringe Rack	*Holds four 0.5 µl to 10 ml syringes*

*** Low RFI (Radio Frequency Interference) Pump available*

**** Push/Pull pump can hold syringes up to 140 ml if full stroke is not required. Larger syringes will not fully infuse or withdraw. Max of 50 ml syringe if full stroke is required.*

Choosing the Right Pump for Your Application & Budget
(continued)

SYRINGE PUMP QUESTIONS (CONTINUED)

- What is the viscosity of the liquid you are pumping? See pump reference page 114
- What are the pressure requirements of your experiment? See pump reference pages 114-115
- Does the pump need to continuously infuse over a 24 hour period of time?
- Does the pump need to be programmable?
- Does the pump need to be controlled with a computer?
- Does the pump need to have TTL capabilities (ex. external control of valves, use of footswitch, etc)?

	INFUSION/WITHDRAWAL						PUSH/PULL	
	PHD ULTRA™ NANOMITE	PUMP 33	PHD 22/2000	PHD ULTRA™ & PHD ULTRA™ CP	PHD ULTRA™ HPSI & PHD ULTRA™ XF	PHD ULTRA™ 4400	PHD ULTRA™ PUSH/PULL	PHD 22/2000
	27	31	32	16 & 18	25	26	23	32
		PC2 55-3333	PC2 70-2001	PC2 70-3006 PC2 88-3015	–	–	PC2 70-3008	PC2 70-2020 PC2 70-2120 PC2 71-2020 PC2 71-2120
	PC2 70-3601	–	PC2 70-2002	PC2 70-3007	PC2 70-3111 PC2 70-3314	PC2 70-3010 PC2 70-3310	PC2 70-3009	PC2 70-2019 PC2 70-2119 PC2 71-2019 PC2 71-2119
	1	2	2 to 10*	2 to 10*	4	1	4 (2 on each side of pusher block)	4 (2 on each side of pusher block)
	0.5 µl	0.5 µl	0.5 µl	0.5 µl	20 ml	0.5 ml	0.5 µl	0.5 µl
	1 ml	140 ml	140 ml	140 ml	200 ml	140 ml	140 ml***	140 ml***
	3.66 pl/min	0.0004 µl/hr	0.0001 µl/hr	1.50 pl/min	50.79 nl/min	3.06 pl/min	1.50 pl/min	0.0001 µl/hr
	3.82 ml/min	106.6 ml/min	220.82 ml/min	216.0 ml/min	144.3 ml/min	216.0 ml/min	216.0 ml/min	220.82 ml/hr
	5 kg (11 lbs) (adjustable)	26 kg (57 lbs)	23 kg (50 lbs) or 30 kg (66 lbs)	34 kg (75 lbs) (adjustable)	197 kg (433 lbs) (adjustable)	91 kg (200 lbs) (adjustable)	34 kg (75 lbs) (adjustable)	22.7 kg (50 lbs) or 29.9 kg (66 lbs)
	USB	RS-232	RS-232	USB + RS-232	USB + RS-232	USB + RS-232	USB + RS-232	RS-232
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	30.5 x 21.6 x 11.1 cm (12.0 x 8.5 x 4.38 in)	15.2 x 31.1 x 28.6 cm (6 x 12.5 x 11.25 in)	15.9 x 22.8 x 27.9 cm (6.3 x 9 x 11 in)	10.16 x 30.5 x 21.6 cm (4 x 12 x 8.5 in)	30.48 x 21.59 x 10.8 cm (12 x 8.5 x 4.25 in)	30.5 x 21.6 x 10.8 cm (12 x 8.5 x 4.25 in)	10.16 x 30.5 x 21.6 cm (4 x 12 x 8.5 in)	15.9 x 22.8 x 27.9 cm (6.3 x 9 x 11 in)
	6.35 x 5.08 x 19.05 (2.5 x 2.0 x 7.5 in)	–	22.9 x 43.2 x 30.5 cm (9 x 17 x 12 in)	–	40.64 x 30.5 x 19.7 cm (16 x 12 x 7.75 in)	–	–	–
	–	6.8 kg (15 lbs)	4.5 kg (10 lbs)	4.5 kg (10 lbs)	13.7 kg (30.2 lbs)	6.4 kg (14 lbs)	4.5 kg (10 lbs)	4.5 kg (10 lbs)

Choosing the Right Pump for Your Application & Budget (continued)

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

Syringe Pump Application Guide

	STANDARD SYRINGE PUMPS						
	PUMP 11 ELITE	PUMP 11 PICO PLUS ELITE	PUMP 11 ELITE NANOMITE	PUMP 22	PUMP 33	NANOCOOL™	PHD 22/2000
SEE PAGE	11	14	15	30	31	28	32
ACCURATE DELIVERY OF COATINGS		X					X
ANIMAL FEEDING	X			X			X
BULK FLUID TRANSFER					X		
CELL CULTURES	X				X		
CELLULAR INJECTION		X	X				X
CONSTANT PRESSURE INFUSIONS							
CONTINUOUS INFUSIONS					X		
DOPING	X			X			X
DRUG DELIVERY (SAME INFUSION RATES)	X			X			X
DRUG DELIVERY (DIFFERENT INFUSION RATES)	X			X (RS-232)*	X		X
DRUG DELIVERY (TIME RELEASED)	X						
DRUG DEVELOPMENT	X			X			X
ELECTROSPINNING	X						X
FLUID BLENDING	X			X (RS-232)*	X		X (RS-232)*
FLUID BLENDING (2 INDEPENDENT CHANNELS)					X		
FLUID SAMPLING	X	X	X	X	X		X
GRADIENTS	X			X (RS-232)*	X		X (RS-232)*
HIGH PRESSURE INJECTION							
HIGHLY CORROSIVE FLUIDS							
HPLC	X	X			X		
INJECTING INTO HIGH PRESSURE REACTION VESSELS		X					
INJECTION PRESSURE CALCULATIONS	X			X			X
INSTRUMENT INJECTIONS	X			X			X
LOW PRESSURE CHROMATOGRAPHY	X						
MASS SPECTROMETRY	X	X		X			X
MEDICAL COATING DELIVERY							
MICRODIALYSIS	X	X		X			
MICROFLUIDICS	X	X					X
MRI STUDIES							
MULTIPLE SIMULTANEOUS FEEDING STATIONS	X			X (RS-232)*			X (RS-232)*
NANOFLUIDICS		X					X
NUTRITIONAL STUDIES	X			X			X
OEM MODULES							
OOCYTE APPLICATIONS		X	X				
PATCH CLAMPING							
REMOTE PUMPING OF HAZARDOUS MATERIAL			X				X
STEM CELL INJECTIONS							
STEREOTAXIC INJECTIONS			X				
TITRATIONS	X			X (RS-232)*	X		
VISCOUS SOLUTIONS		X					

**Note: Can be done using RS-232 Computer Control*

Choosing the Right Pump for Your Application & Budget
(continued)

								OEM SYRINGE PUMP MODULES		
PHD ULTRA™	PHD ULTRA™ PUSH/PULL	MRI PHD 22/2000	PHD ULTRA™ HPSI	PHD ULTRA™ 4400	PHD ULTRA™ CP	PHD ULTRA™ XF	MICROLITER	MILLILITER	HIGH PRESSURE
18	23	34	25	26	16	25	38	38	39-40
X	X								X
X									
X	X								
X	X								
X							X	X	
	X						X	X	
X									
X									
			X (RS-232)*						
X				X					
X									
X									X
X				X			X	X	
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X							X	X	
X							X	X	
			X	X					X
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X			X	X					X

Application Selection Guide

With more than 60 years of experience in the development, manufacture, and support of the highest quality syringe pumps, and 100 years in fluidics, Harvard Apparatus has a wealth of experience to share in recommending the right solution for your application. Following is only a partial guide of some application suggestions. Contact our Technical Support group for their input or with questions for the best pump to meet your need.

If you do not see what you feel is the best solution for your application, give us a call as we often develop or modify standard products for particular applications at little or no extra cost.

Neuroscience

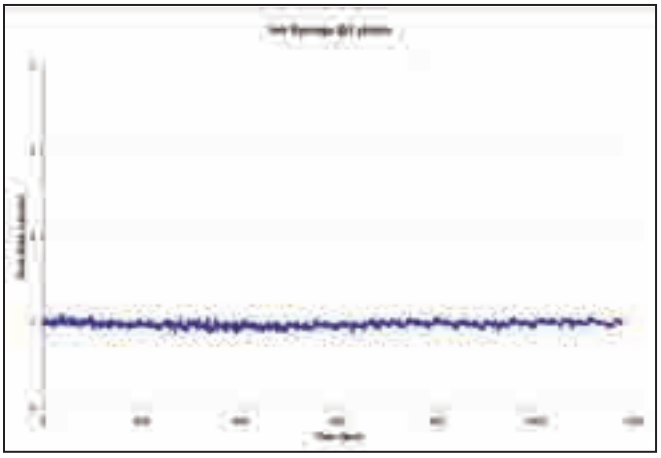
Applications in this area include: microdialysis and site specific microinjection into various brain regions.

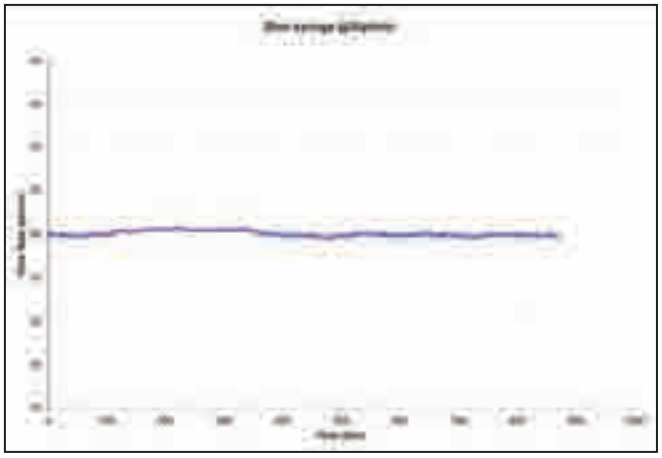
- **For stereotaxically guided, single channel microinjection,** see the Pump 11 Elite Nanomite on page 15, or the PHD ULTRA™ Nanomite on page 27.
- **For single or dual probe microdialysis,** see the Pump 11 Elite on page 11 or Pico Plus Elite on page 14.
- **For applications using a liquid switch, or for running multiple experiments simultaneously,** see the PHD ULTRA™ on page 18.

Infusion and Drug Delivery

Delivering accurate volumes and flows is critical to maintaining dosing regimens, interpretation of pharmacokinetics and other data.

- **For single or dual channel infusions,** see the Pump 11 Elite on page 11, or PHD ULTRA™ on page 18.
- **If MRI or MRI Compatible PET studies are being conducted**, see the PHD 22/2000 on page 34.
- **To run multiple studies from a single pump,** see the PHD ULTRA™ on page 18.





Neuroscience References

Differences in performance between Sprague–Dawley and Fischer 344 rats in positive reinforcement tasks, **PHARMACOLOGY BIOCHEMISTRY AND BEHAVIOR**, Volume 89, Issue 1, March 2008, Pages 17-22
J Appl Physiol 106: 1793-1799, 2009.

Processing cardiovascular information in the vlPAG during electroacupuncture in rats: roles of endocannabinoids and GABA, **PHARMACOLOGY BIOCHEMISTRY AND BEHAVIOR**, J Appl Physiol 106: 1793-1799, 2009. First published March 26, 2009; doi:10.1152/japplphysiol.00142.2009 8750-7587/09

DCPIB, a specific inhibitor of volume regulated anion channels (VRACs), reduces infarct size in MCAo and the release of glutamate in the ischemic cortical penumbra, **EXPERIMENTAL NEUROLOGY**, Volume 210, Issue 2, April 2008, Pages 514-520

Infusion and Drug Delivery References

Prosthetic systems for therapeutic optical activation and silencing of genetically-targeted neurons, **PROC SOC PHOTO OPT INSTRUM ENG.**, 2008; 6854: 68540H. doi: 10.1117/12.768798.

Intravenously administered phosphodiesterase 4 inhibitors dilate retinal blood vessels in rats, **EUROPEAN JOURNAL OF PHARMACOLOGY**, Volume 602, Issue 1, 5 January 2009, Pages 112-116

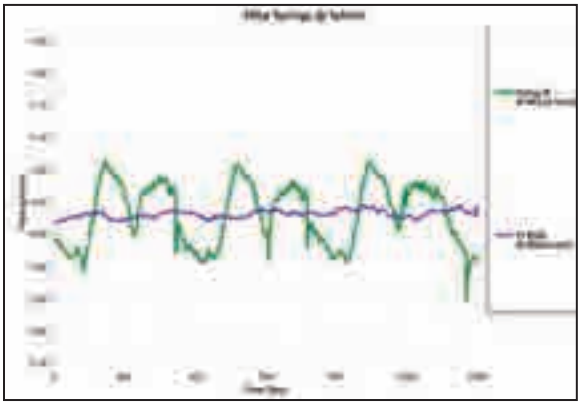
Electroencephalogram spindle activity during dexmedetomidine sedation and physiological sleep, **ACTA ANAESTHESIOLOGICA SCANDINAVICA**, Volume 52, Issue 2, pages 289–294, February 2008

Application Selection Guide (continued)

Cell Biology

Cellular studies typically involve the injection of very small volumes under controlled conditions. Several models offer a foot pedal accessory to start/stop flow on command.

- **For cellular microinjections of plasmids, viruses, and the like,** see either the Pump 11 Pico Plus Elite on page 14, PHD ULTRA™ Nanomite on page 27 or the Pump 11 Elite Nanomite on page 15.



Cell Biology References

Microfluidic electroporation for selective release of intracellular molecules at the single-cell level, **ELECTROPHORESIS**, Volume 29, Issue 14, pages 2939–2944, No. 14 July 2008

L-selectin-mediated lymphocyte-cancer cell interactions under low fluid shear conditions, **THE JOURNAL OF BIOLOGICAL CHEMISTRY**, 283, 15816-15824

Shear assay measurements of cell adhesion on biomaterials surfaces, **MATERIALS SCIENCE AND ENGINEERING: C**, Volume 29, Issue 4, 5 May 2009, Pages 1293-1301

Chemical & Industrial/Electrospinning

Where chemical synthesis, pressurized systems, and other applications demand high performance Harvard Apparatus has the right solution.

- **For high pressure applications,** consider the **NEW** PHD ULTRA™ XF and PHD ULTRA™ HPSI with stainless steel syringes on page 25 or the PHD ULTRA™ 4400 on page 26.

Harvard Apparatus pumps are used in creating Nano and Micro scale polymer fibers in a high voltage field. The stability of flow and flexibility of use, in the PHD ULTRA™ series pumps, makes it easy to alter the variables relating to successful electrospinning. Our pumps include a grounded power supply and can be supplied with a grounding strap, which will shunt any high voltage arcs to ground.

Chemical and Industrial/Electrospinning References

Microfluidic electroporation for selective release of intracellular molecules at the single-cell level, **ANAL. CHEM.**, 2008, 80 (9), pp 3112–3122

Optical and electrical properties of indium tin oxide nanofibers prepared by electrospinning, **NANOTECHNOLOGY,** 2008 19 145603

Manufacture of small calibre quadruple lamina vascular bypass grafts using a novel automated extrusion-phase-inversion method and nanocomposite polymer, **JOURNAL OF BIOMECHANICS,** Vol. 42, ssue 6, Pages 722-730 (16 April 2009)

Mass Spectrometry Calibration and Electrospray Ionization

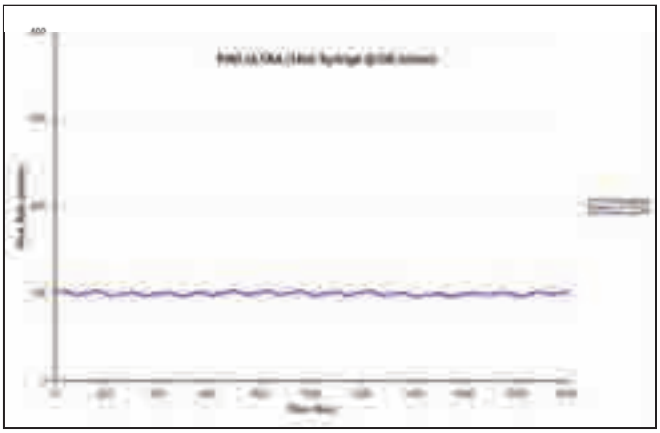
Calibration and Electrospray Ionization

Where precise volume delivery and pulse free flow are required for optimum instrument calibration or solvent elimination, the Pump 11 series has long been the industry standard for manufacturers in OEM configurations and end users. See the Pump 11 Elite on page 11, and Pump 11 Pico Plus Elite systems on page 14.

Additionally, use of the gradient capabilities of the Pump 11 Elite or PHD ULTRA™ Series allows for automated multi-point calibration when performing GLP studies.

MALDI-TOF Matrix Addition

Using the Nanomite with its detachable delivery and electronics allows for easy placement of the syringe over the target to facilitate the dispensing of the appropriate matrix. See the PHD ULTRA™ Nanomite on page 27 or the Pump 11 Elite Nanomite on page 15.



Mass Spectrometry Calibration References

Which Electrospray-Based Ionization Method Best Reflects Protein-Ligand Interactions Found in Solution? A Comparison of ESI, nanoESI, and ESSI for the Determination of Dissociation Constants with Mass Spectrometry, **JOURNAL OF THE AMERICAN SOCIETY FOR MASS SPECTROMETRY,** Volume 19, Issue 3, March 2008, Pages 332-343

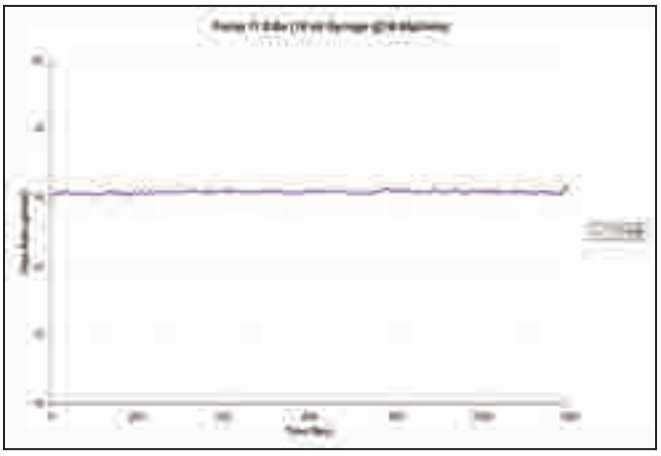
Gas-phase IR spectra of intact α-helical coiled coil protein complexes, International Journal of Mass Spectrometry, **INTERNATIONAL JOURNAL OF MASS SPECTROMETRY,** Volume 283, Issues 1-3, 1 June 2009, Pages 161-168

Fragmentation patterns of newly isolated cassane butenolide diterpenes and differentiation of stereoisomer by tandem mass spectrometry, **JOURNAL OF MASS SPECTROMETRY,** Volume 43, Issue 10, pages 1413–1420, October 2008

Application Selection Guide (continued)

Microfluidics

The PHD ULTRA™ series and Pump 11 Elite series pumps have the performance and flow stability required in micro and nanofluidics. These pumps can be used to mix flow streams and/or create multiple parallel flow streams. Another option is the NanoLeader pressure pump that can push and/or pull fluids using positive or negative air pressure, creating the smoothest flow possible.



Microfluidics References

Spiropyran modified micro-fluidic chip channels as photonically controlled self-indicating system for metal ion accumulation and release, **SENSORS AND ACTUATORS B: CHEMICAL,** Volume 140, Issue 1, 18 June 2009, Pages 295-303

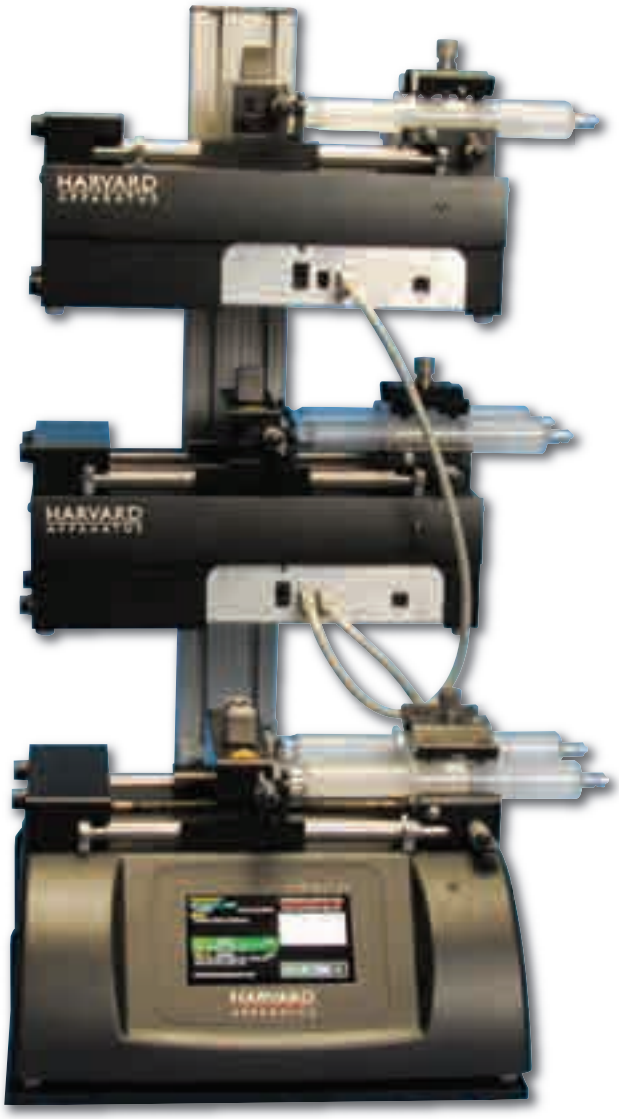
Microfluidic high-throughput encapsulation and hydrodynamic self-sorting of single cells, **PNAS,** March 4, 2008 vol. 105 no. 9 3191-3196

In vitro analysis of a hepatic device with intrinsic microvascular-based channels, **BIOMEDICAL MICRODEVICES** Volume 10, Number 6, 795-805

Plasmonic Nanoholes in a Multichannel Microarray Format for Parallel Kinetic Assays and Differential Sensing, **ANAL. CHEM.,** 2009, 81 (8), pp 2854–2859

Nano/Micro Liquid Chromatography

The advanced programming capabilities of the PHD ULTRA™ and the Pump 11 Elite Syringe Pumps allow for the easy generation of binary or ternary gradients at flow rates ranging from 100 nl/min to 1.0 ml/min at pressures up to 7,500 PSI. Depending on the number of syringes used, up to one liter of mobile phase may be delivered from each pump used.



Pump 11 Elite

KEY FEATURES

- Easy to use touch screen and icon interface
- Outstanding flow performance
- Easily run simple to complex methods without a PC
- Alphanumeric keypad for easy Method naming and recall
- Adjustable linear force up to 35 lbs
- Upgrade new versions of software remotely
- Legendary reliability – 2 year warranty

APPLICATIONS

- Microfluidics
- Drug/Nutritional Delivery
- Microdialysis
- Emulsification
- Bioreactors
- Electrospinning
- Mass Spectrometry

The Pump 11 Elite Series of syringe pumps expands its capabilities to satisfy your experimental requirements. These compact syringe pumps carry on the tradition as the premier workhorse infusion pump, offering unparalleled ease of use with a high resolution color touch screen with intuitive icon interface. The Pump 11 Elite Series allows you to create, save and run simple to complex methods without a PC.

Superior Performance

These syringe pumps have a new mechanism that includes a tight gripping, very secure syringe clamp for syringes ranging from 0.5 µl to 60 ml (single syringe) and 0.5 µl to 10 ml (dual syringe). The Pump 11 Elite Series offers enhanced flow performance with high accuracy and smooth flow from 1.26 pl/min to 88.40 ml/min (26.02 ml/min for dual syringe rack).

The Pump 11 Elite Series is available in Infusion Only or Infusion/Withdrawal Programmable Models with single or dual syringe racks. All Pump 11 Elite syringe pumps have a footswitch input and USB serial port for computer control. The Infusion/Withdrawal Programmable models also have RS-485 (or optional RJ-11) ports for daisy chaining pumps and Digital I/O for external control via an independent computer or device (see page 13 for more information on connectivity).

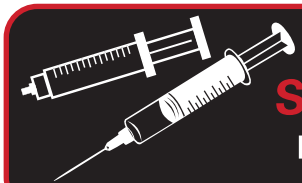
Since 1901 Harvard Apparatus has been supporting bioresearch fluidics requirements with a key milestone being the introduction of the first commercial syringe pump for bioresearch in 1956. Since 1956, over 70,000 satisfied syringe pump users around the world have made Harvard Apparatus syringe pumps the worlds #1 choice.

The Pump 11 Elite Series is a family of accurate, low flow syringe pumps designed for use in applications including: mass spec calibration, drug and nutritional studies, reactor dosing, electrospinning and more.

Easy-to-Use Interface

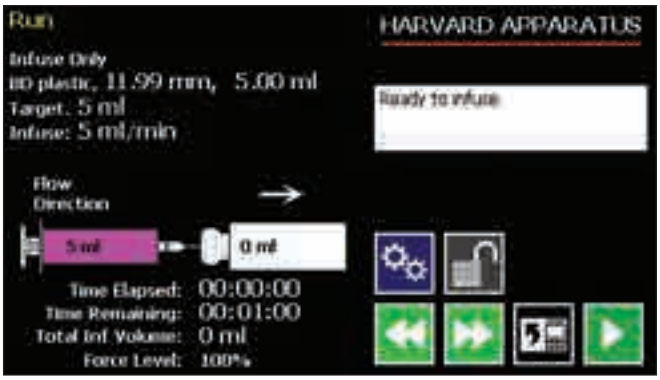
The Pump 11 Elite Syringe Pumps are very easy to use with an LCD color touch screen and icon interface. The Message Area of the touch screen is used to display helpful instructions for the currently displayed screen. It is also used to display error or warning messages to indicate problem conditions in a Method or error conditions during pump operation. The Run Screen shows all of the pump parameters on one screen for easy review.

The software is organized into three main navigational branches, the quick start Methods, user-defined Methods, and system settings. You can control operations directly through the touch screen or remotely from an independent computer or device via the external I/O interface.



Syringe Options
Please see pages 50-59

Pump 11 Elite (continued)



Pump Models

The Pump 11 Elite Syringe Pumps are available in two configurations designed for different operating environments and varying degrees of operational flexibility.

1. **Infusion Only (single and dual syringe models):** This model supports infusion operations at user-defined flow rates and with selectable target volume or time values to control the total infusion volume. The Infusion Only models do not include programmable, user-defined Methods.
2. **Infusion/Withdrawal Programmable (single and dual syringe models):** This model supports infuse only, withdraw only, infuse/withdraw and withdraw/infuse operations at user-defined flow rates and with selectable target volume or time. This model also allows users to create and store up to two user-defined Methods of 50 steps each on the pump.

Accessories

A full range of accessories are compatible with the Pump 11 Elite including syringe heaters, in-line heaters and coolers, nanofluidic circuits, connectors, tubing, syringes and more.

Program Description

To operate the Pump 11 Elite, the user defines all the required parameters for infusing or withdrawing liquids through a Method. This may be a Quick Start Method, Pre-Programmed or User-Defined Method. The basic operation is a simple 3-step procedure:

1. **Select a method**
2. **Enter operating parameters**
3. **Preview or Run your method**

Quick Start Methods are simple infusions, withdrawals or a combination (depending upon the model). Custom user-defined Methods can be created when more advanced programming is required. The setup for a custom Method is easy using the standard profiles found on all Infusion/Withdrawal Programmable Elite Models. The list of available profiles is:

Constant Rate	**Gradient (binary)**
Ramp	**Autofill**

By programming custom (user-defined) Methods into the pump, multi-user errors are reduced. Easily transfer Methods to other pumps and/or download Methods from a PC. Forget having to duplicate Method-development efforts for each new pump added to your system.

Alarms

There are several alarms available on the Model 11 Elite Syringe Pumps:

- **End of Run**
- **Near End of Run**
- **Power Up**
- **Stall**

Advanced Documentation Features

- **Download experimental parameter information to PC**
- **Alphanumeric keypad for method naming**

Adjustable Force

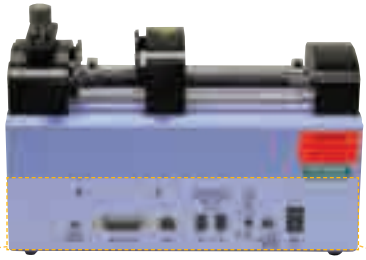
The maximum linear force of the Pump 11 Elite is 16 kg (35 lbs). Depending upon the syringes you are working with and your overall experimental setup you may want to adjust the amount of force applied to the pusher block. You can select a percentage of the total force from 20% to 100%. Refer to the user's manual for suggested force level settings.

CONTROL MULTIPLE PUMPS VIA DAISY CHAIN WITH RS-485

Pump 11 Elite (continued)

Advanced Connectivity

The infusion only Pump 11 Elite Syringe Pumps come standard with a Footswitch input and USB connector. The infusion/withdrawal programmable Pump 11 Elite Syringe Pumps include a Footswitch input, USB, RS-485 and I/O connectors. There is also an option for RJ-11 connectors on the programmable pumps. This option has to be ordered at the time the pump is ordered.



OPTIONAL RJ-11 CONNECTORS (for pump-to-pump communication)

FOOTSWITCH INPUT

USER I/O CONNECTOR

USB SERIAL INPUT (for communication from PC)

RS-485 CONNECTORS (for pump-to-pump communication)

UNIVERSAL POWER INPUT

Pump 11 Elite Specifications

TYPE	Microprocessor single or dual syringe, infusion only or infusion/withdrawal programmable
ACCURACY	±0.5%
REPRODUCIBILITY	±0.05%
SYRINGE:	
Type	Plastic or glass
Size (single syringe)	0.5 µl to 50/60 ml
Size (dual syringe)	0.5 µl to 10 ml
FLOW RATE:	
Single Syringe	1.26 pl/min to 88.4 ml/min
Dual Syringe	1.26 pl/min to 26.02 ml/min
DISPLAY	4.3" WQVGA TFT color display with touch screen
CONNECTORS:	
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15-pin D-Sub Connector
Footswitch	mini phono jack
AVERAGE LINEAR FORCE	16 kg (35 lbs) @ 100% Force Selection
STEP RESOLUTION	0.069 µm/µstep
INPUT POWER	12-30 VDC
INPUT POWER CONNECTION	2.5 mm ID x 5.5 mm OD male plug
POWER SUPPLY	100-240 VAC, 50/60 Hz, 8 Watts Universal Power Supply, Use Only a Harvard Apparatus Approved Power Supply and Line Cord
DIMENSIONS, H x W x D	22.6 x 17.78 x 15 cm (9 x 7 x 6 in)
WEIGHT	2.1 kg (4.6 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

FOOTSWITCH INPUT	Start and stop a pump
USB SERIAL INPUT	Control your pump with a computer
RS-485 CONNECTORS	Connect multiple pumps together (daisy chain up to 99 pumps)
	Connect satellite pumps to the Master pump for binary gradient system (% composition)
RJ-11 CONNECTORS (OPTION)	Connect multiple pumps together (daisy chain)
USER I/O CONNECTOR	
Direction Control Input	Set pump to infuse or withdraw
Trigger Input	Connect an external device to start and stop a pump or Method
Trigger 1 Output	Signal another device to start and stop a pump or Method
Run indicator	Connect an external LED or monitoring device to a pump

Order #	Product
PC2 70-4500	Pump 11 Elite Infusion Only Single Syringe
PC2 70-4501	Pump 11 Elite Infusion Only Dual Syringe
PC2 70-4504	Pump 11 Elite Infusion/Withdrawal Programmable Single Syringe
PC2 70-4505	Pump 11 Elite Infusion/Withdrawal Programmable Dual Syringe
Accessories	
PC2 70-4000	RS-485 Cable for Pump-to-Pump Communication, 0.5 m (1.6 ft)
PC2 70-4001	RS-485 Cable for Pump-to-Pump Communication, 2 m (6.6 ft)
PC2 70-4020	RS-485 Extension Cable, 9.1 m (30 ft)
PC2 70-4002	USB Cable for PC-to-Pump Communication, 2 m (6.6 ft)
PC2 70-4003	USB Cable for PC-to-Pump Communication, 5 m (16.4 ft)
PC2 70-4006	Adapter, D-sub 15 to Term, Blk
PC2 72-8340	Adapter, USB to Serial
PC2 70-2215	Footswitch (with Phono Plug)
PC2 55-7760	Cable Assy, Daisy Chain, Legacy RS-232 RJ-11, 0.6 m (2 ft)
PC2 72-2478	Cable Assy, Daisy Chain, Legacy RS-232 RJ-11, 2.1 m (7 ft)
PC2 55-8000	Adapter for 25 ml, Hamilton GasTight™ Syringes

Pump 11 Pico Plus Elite

KEY FEATURES

- Easy to use touch screen and icon interface
- Outstanding flow performance
- Easily run simple to complex methods without a PC
- Alphanumeric keypad for easy Method naming and recall
- Adjustable linear force up to 35 lbs
- Upgrade new versions of software remotely
- Legendary reliability – 2 year warranty

APPLICATIONS

- Microfluidics
- Drug/Nutritional Delivery
- Microdialysis
- HPLC
- Cellular Injections
- Mass Spectrometry

The Pump 11 Pico Plus Elite is the lowest flow, highest accuracy syringe pump. It offers enhanced flow performance with high accuracy and smooth flow from 0.54 pl/min to 11.70 ml/min. This dual syringe pump offers unparalleled ease of use with a high resolution color touch screen with intuitive icon interface. The Pump 11 Pico Plus Elite allows you to create, save and run simple to complex methods without a PC.

The Pump 11 Pico Plus Elite is a dual syringe Infusion/Withdrawal Programmable Model. It has a footswitch input, USB serial port for computer control, RS-485 ports for daisy chaining pumps and Digital I/O for external control via an independent computer or device (see page 13 for more information on connectivity). There is also an option of daisy chaining pumps through the RS-232 (RJ-11) ports. For more information on the Pump 11 Pico Plus Elite including features and programming see the Pump 11 Elite on page 11.

Pump 11 Pico Plus Elite Specifications	
TYPE	Microprocessor dual syringe, infusion/withdrawal programmable
ACCURACY	±0.35%
REPRODUCIBILITY	±0.05%
SYRINGE:	
Type	Plastic or glass
Size Minimum	0.5 µl
Size Maximum	10 ml
FLOW RATE:	
Minimum	0.54 pl/min
Maximum	11.70 ml/min
DISPLAY	4.3" WQVGA TFT color display with touch screen
CONNECTORS:	
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15-pin D-Sub Connector
Footswitch	Mini phono jack
AVERAGE LINEAR FORCE	16 kg (35 lbs) @ 100% Force Selection
STEP RESOLUTION	0.031 µm/µstep
INPUT POWER	12-30 VDC
INPUT POWER CONNECTION	2.5 mm ID x 5.5 mm OD male plug
POWER SUPPLY	100-240 VAC, 50/60 Hz, 8 Watts Universal Power Supply, Use Only a Harvard Apparatus Approved Power Supply and Line Cord
DIMENSIONS, H x W x D	22.6 x 17.78 x 15 cm (9 x 7 x 6 in)
WEIGHT	2.1 kg (4.6 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

Order #	Product
PC2 70-4506	Pump 11 Pico Plus Elite Infusion/Withdrawal Programmable Dual Syringe

Pump 11 Elite Nanomite

KEY FEATURES

- Easy-to-use LCD color touch screen with GUI interface
- Light weight makes it ideal for hand-held or stereotaxic injection
- Easily program simple to complex Methods without a PC
- Create and store up to 2 Methods

APPLICATIONS

- Cellular Injections
- Drug Delivery
- Microinjections
- Hand-Held Automated Delivery
- Stereotaxic Injections
- Regenerative Medicine

The Pump 11 Elite Nanomite is a single syringe infusion/withdrawal programmable syringe pump. This pump allows you to create, save and run simple to complex Methods without a PC. The flow rate range is 3.66 pl/min to 3.82 ml/min with 11 lbs of adjustable force across the entire flow rate range.

The Pump 11 Elite Nanomite has a footswitch input, USB serial port for computer control, RS-485 ports for daisy chaining pumps and Digital I/O for external control via an independent computer or device. There is also an option for daisy chaining pumps through the RS-232 (RJ-11) ports. This option must be ordered at the time the pump is ordered. See page 13 for more information on connectivity.

This pump consists of a control unit, an injection unit, a 6 foot cable to connect the two units and a footswitch. For more information on the Pump 11 Elite Nanomite including features and programming, see the Pump 11 Elite on page 11.

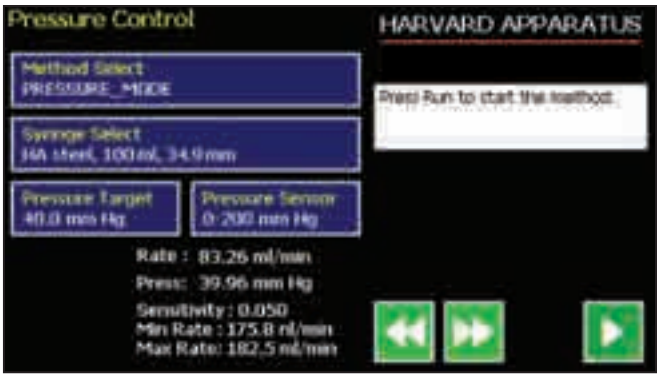
For filling small volume syringes & needles, see the HA Priming Kit on page 90.

Pump 11 Elite Nanomite Specifications	
TYPE	Microprocessor single syringe, infusion/withdrawal programmable
ACCURACY	±0.5%
REPRODUCIBILITY	±0.05%
SYRINGES (MIN./MAX.)	0.5 µl / 1 ml
FLOW RATE:	
Minimum	3.66 pl/min
Maximum	3.82 ml/min
DISPLAY	4.3" WQVGA TFT color display with touch screen
CONNECTORS:	
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15-pin D-Sub Connector
Footswitch	mini phono jack
AVERAGE LINEAR FORCE	5 kg (11 lbs) @ 100% force selection
STEP RESOLUTION	0.198 µm/µstep
INPUT POWER	12-30 VDC
INPUT POWER CONNECTION	2.5 mm ID x 5.5 mm OD male plug
POWER SUPPLY	100-240 VAC, 50/60 Hz, 8 Watts Universal Power Supply, Use Only a Harvard Apparatus Approved Power Supply and Line Cord
DIMENSIONS, H x W x D:	
Control Box	22.6 x 17.78 x 9.32 cm (9 x 7 x 3.67 in)
Mechanism	6.35 x 5.08 x 19.05 cm (2.5 x 2.0 x 7.5 in)
WEIGHT	1.96 kg (4.32 lbs)
REGULATORY CERTIFICATIONS	CE, EU RoHS

Order #	Product
PC2 70-4507	Pump 11 Elite Nanomite Infusion/Withdrawal Programmable Single Syringe

NEW PHD ULTRA™ CP Constant Pressure Syringe Pump

PC2 88-3015 PHD ULTRA™ CP Infusion/Withdrawal Programmable



Our user-friendly touch screen interface allows for simple control of either constant pressure or constant flow-based applications.

KEY FEATURES

- Enables continuous pressure-controlled infusion
- Use in constant flow or constant pressure mode
- Enhances safety for sensitive infusion targets and physiological experimentation
- Compatible with a wide range of pressure transducers
- Automatically adjusts flow rate to maintain constant pressure
- Legendary Reliability - 2 year warranty

APPLICATIONS

- Short-term organ perfusion studies that require the maintenance of physiologic conditions
- Introduction of chemical reactants in a controlled manner
- Ocular injections and perfusions
- Small animal whole-body perfusions
- Constant pressure microfluidic mixing
- Administration of genetic material into organs without viral vectors

Constant Pressure Syringe Pump Technology Breakthrough

The PHD ULTRA™ CP Syringe Pump is the first of its kind to allow operation under constant pressure or constant flow. Historically, the only means available to dispense at constant pressure has involved the use of various amplifiers and other accessories/software. The PHD ULTRA™ CP Syringe Pump, when combined with virtually any commercially available pressure transducer/amplifier combination with 0-10 V DC analog output, results in a constant pressure dispensing system. This system can deliver fluids with an applied force up to 1,000 lbs (depending upon the pump).

Superior Functionality

Using Harvard Apparatus syringe pump technology and software-controlled pressure monitoring, the PHD ULTRA™ CP Syringe Pump is able to maintain a user-defined system pressure ±2%.

A user-adjustable sensitivity setting allows for the customization of the system response time necessary to attain the set pressure. The PHD ULTRA™ CP Syringe Pump allows the user to set pressures in the units of their choice including mmHg, kPa, and psi.

Pressure & Flow Rate Data

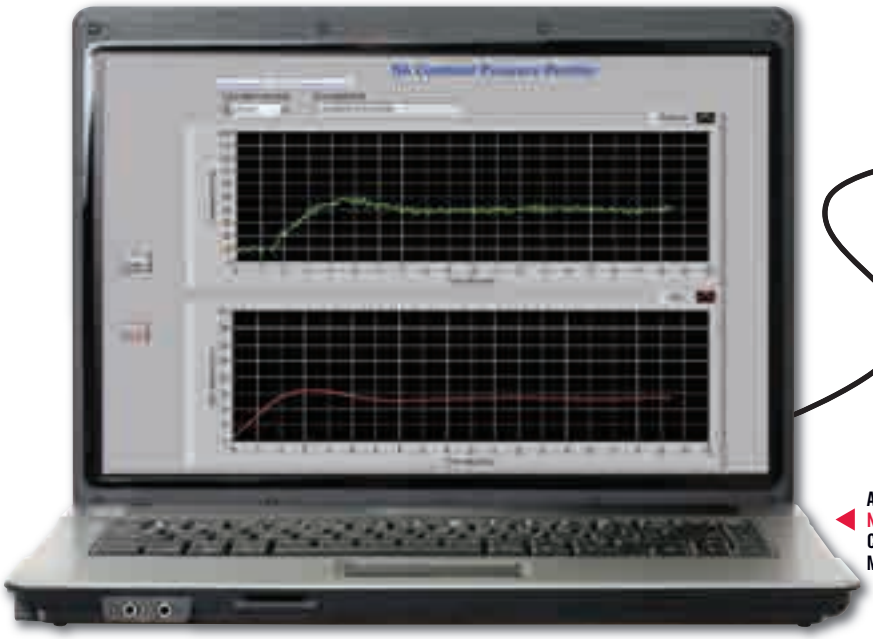
Data can be monitored via RS-232 from the PHD ULTRA™ CP Syringe Pump to a PC. In practice, the 0-10 V analog output of a pressure transducer amplifier is connected to the analog input on the rear panel of the pump. The amplifier or signal conditioner can be provided by the customer, or accomplished with various transducers and amplifiers available from Harvard Apparatus, see pages 46 to 48. The pressure range may be scaled to fit the available transducer voltage output for systems that output less than 10 V. While in constant pressure mode, in addition to the set and actual pressure, the pump displays the flow rate. This data may be output for further analysis with a variety of data acquisition packages.

Accuracy & Reproducibility

In addition to constant pressure mode, the PHD ULTRA™ CP Syringe Pump may also be used in flow mode with its world renowned accuracy and reproducibility.

All PHD ULTRA™ CP Syringe Pumps are infusion/withdrawal programmable models. When used in flow mode, these offer programmable features such as method storage and flow programming functions to allow the user to create simple to complex methods (see page 20). The PHD ULTRA™ CP Syringe Pump is available in a variety of configurations to suit the desired pressure or flow rate ranges.

NEW PHD ULTRA™ CP Constant Pressure Syringe Pump



A screen shot of the NEW Harvard Apparatus Constant Pressure Monitoring Software*.

PC2 88-3016 PHD ULTRA™ CP 4400 Infusion/Withdrawal Programmable

Specifications	PHD ULTRA™ CP	PHD ULTRA™ CP Remote	PHD ULTRA™ CP 4400	PHD ULTRA™ CP 4400 Remote	PHD ULTRA™ CP HPSI Remote	PHD ULTRA™ XF-CP Remote
TYPE	Microprocessor, multiple syringe, infusion/withdrawal, programmable	Microprocessor, multiple syringe, infusion/withdrawal, programmable	Microprocessor, multiple syringe, infusion/withdrawal, programmable	Microprocessor, multiple syringe, infusion/withdrawal, programmable	Microprocessor, multiple syringe, infusion/withdrawal, programmable	Microprocessor, multiple syringe, infusion/withdrawal, programmable
FLOW ACCURACY	±0.25%	±0.25%	±0.35%	±0.35%	±0.5%	±0.5%
PRESSURE ACCURACY	< ±2%	< ±2%	< ±2%	< ±2%	< ±2%	< ±2%
SYRINGE SIZE, MIX/MAX	0.5 µl to 140 ml	0.5 µl to 140 ml	0.5 µl to 140 ml	0.5 µl to 140 ml	20 ml to 200 ml	20 ml to 200 ml
# SYRINGES	2-10	2-10	1	1	1-4	1-4
FLOW RATE:						
MINIMUM	1.50 pl/min	1.50 pl/min	3.06 pl/min	3.06 pl/min	50.79 nl/min	50.79 nl/min
MAXIMUM	216.0 ml/min	216.0 ml/min	216.0 ml/min	216.0 ml/min	144.3 ml/min	144.3 ml/min
CONNECTORS:						
USB (PC-to-Pump)	Type B	Type B	Type B	Type B	Type B	Type B
RS-232 (PC-to-Pump)	9-pin D-Sub	9-pin D-Sub	9-pin D-Sub	9-pin D-Sub	9-pin D-Sub	9-pin D-Sub
RS-485* (Pump-to-Pump)	IEEE-1394, 6 pos	IEEE-1394, 6 pos	IEEE-1394, 6 pos	IEEE-1394, 6 pos	IEEE-1394, 6 pos	IEEE-1394, 6 pos
I/O & TTL	15-pin D-Sub	15-pin D-Sub	15-pin D-Sub	15-pin D-Sub	15-pin D-Sub	15-pin D-Sub
AVERAGE LINEAR FORCE	34 kg (75 lbs) at 100%	34 kg (75 lbs) at 100%	91 kg (200 lbs) at 100%	91 kg (200 lbs) at 100%	200 kg (433 lbs) at 100%	454.5 kg (1,000 lbs) at 100%
MAXIMUM PRESSURE (with 100 ml Syringe)	50 psi	50 psi	135 psi	135 psi	290 psi	670 psi
DIMENSIONS CONTROL BOX	30.5 x 21.6 x 17.8 cm (12 x 8.5 x 7 in)	30.5 x 21.6 x 10.6 cm (12 x 8.5 x 4.3 in)	30.5 x 21.6 x 10.6 cm (12 x 8.5 x 4.3 in)	30.5 x 21.6 x 18.5 cm (12 x 8.5 x 7.3 in)	30.5 x 21.6 x 10.6 cm (12 x 8.5 x 4.3 in)	30.5 x 21.6 x 10.6 cm (12 x 8.5 x 4.3 in)
DIMENSIONS REMOTE BOX	N/A	30.5 x 14 x 16.5 cm (12 x 5.5 x 6.5 in)	N/A	30.5 x 14 x 17.8 cm (12 x 5.5 x 7 in)	41.9 x 30.5 x 19.1 cm (16.5 x 12 x 7.5 in)	41.9 x 30.5 x 19.1 cm (16.5 x 12 x 7.5 in)
WEIGHT	4.5 kg (10 lbs)	4.8 kg (10.5 lbs)	5.4 kg (12 lbs)	7.7 kg (17 lbs)	13.6 kg (30 lbs)	20.9 kg (46 lbs)
VOLTAGE RANGE	100-240 VAC; 50/60 Hz	100-240 VAC; 50/60 Hz	100-240 VAC; 50/60 Hz	100-240 VAC; 50/60 Hz	100-240 VAC; 50/60 Hz	100-240 VAC; 50/60 Hz
Order #	**PC2 88-3015**	**PC2 88-3315**	**PC2 88-3016**	**PC2 88-3316**	**PC2 88-3113**	**PC2 88-3314**

Note: PC laptop not included.

PHD ULTRA™ Advanced Syringe Pumps

CE

KEY FEATURES

- New patent pending drive mechanism for unmatched smooth flow, accuracy and precision
- For operation at pl/min to ml/min flow rates
- Easily program simple to complex methods without a PC
- Alphanumeric keypad for easy Method naming and recall
- Real and relative time clocks
- Intuitive touch screen and icon interface
- Vertical or horizontal orientation
- Adjustable linear force to 75 lbs
- Multi-syringe racks for multi-channel operation or large capacity reservoir
- Legendary reliability – 2 year warranty

APPLICATIONS

- Microfluidics
- Drug/Nutritional Delivery
- Electrospinning
- Reaction Chamber Addition
- Mass Spec Calibration
- Feeding Cells
- Low Pressure Chromatography
- Continuous Flow
- Flow Programming
- Gradients
- % Composition Step Changes
- Large Flow Deliveries
- I/O Interactive Experiments

PHD ULTRA™

The PHD ULTRA™ is the solution for your most demanding fluidics applications. This pump represents the latest technology in syringe pumps and was developed utilizing the feedback of the world's largest population of syringe pump users.

The PHD ULTRA™ will change the way you think about syringe pumps. There are three major reasons the PHD ULTRA™ is the new standard for syringe pumps:

1. **Patent pending mechanical drive mechanism and syringe holding mechanics to achieve the highest performance of any syringe pump.**
2. **EZ PRO Software and user interface allow easy programming of Methods from simple to complex, all without the use of a PC.**
   - *Preprogrammed Methods for simple to complex operations that allow you to be up and running with the touch of a button.*
   - *LCD, high resolution color touch screen for powerful functionality, yet very easy to use.*
3. **Levels of Versatility**
   a. Configurations: *Standard, push-pull, remote, high pressure, multi-racks.*
   b. Connectivity: *For USB or RS-232 computer control; RS-485 or optional RJ-11 for daisy chain (control multiple pumps).*
   c. Orientation: *Horizontal or vertical orientation to optimize bench space or to minimize tubing.*

Since 1901 Harvard Apparatus has been supporting bioresearch fluidics requirements beginning with the introduction of the first commercial syringe pump for bioresearch in 1956. Since 1956, over 70,000 satisfied syringe pump users around the world have made Harvard Apparatus syringe pumps the world's #1 choice.

The PHD ULTRA™ Syringe Pump series is a family of high-accuracy, easy to use, rugged pumps designed for versatile applications including mass spectrometry calibration, drug and nutritional studies, microdialysis, dispensing, chromatography, LC/HPLC and more.

PHD ULTRA™ Advanced Syringe Pumps (continued)

Highest Accuracy and Precision

The PHD ULTRA™ syringe pump family has a new patent pending fluidics drive mechanism which assures ease of use and high performance, for the smoothest, most accurate flow rates of any syringe pump. Flow rates of 1.50 pl/min to 216.0 ml/min are accurate within 0.25% and reproducible within 0.05%. A microprocessor-controlled, small step angle stepper motor drives a lead screw and pusher block. Advanced micro-stepping techniques are employed to further reduce the step angle to eliminate flow pulsation.

Maximum Experimental Versatility

This pump can be oriented vertically or horizontally for optimum experimental connectivity. This pump comes standard to hold 2 syringes, but can be purchased with 3 other syringe racks: 6/10 syringe rack, 4 x 140 ml syringe rack and 4 x microliter syringe rack. Syringe racks can be ordered separately. Multi-syringe racks provide multi-channel operation or serve as a large capacity reservoir.

Syringe Racks

- **The standard 2-syringe rack holds 2 syringes from 0.5 µl to 140 ml**
- **The 4 x 140 multi-rack holds four 60 ml or 140 ml plastic syringes only**
- **6/10 multi-rack will hold up to 10 syringes from 0.5 µl to 20 ml and up to 6 syringes from 30 ml to 60 ml**
- **The microliter syringe rack independently holds 4 syringes, from 0.5 µl to 10 ml, enabling syringes of different sizes to run simultaneously.**

Easy-to-Use Interface

The PHD ULTRA™ Syringe Pumps are very easy to use with an LCD color touch screen and icon interface. The Message Area of the touch screen is used to display helpful instructions for the currently displayed screen. It is also used to display error or warning messages to indicate problem conditions in a Method or error conditions during pump operation. The Run Screen shows all of the pump parameters on one screen for easy review.

Pump Models

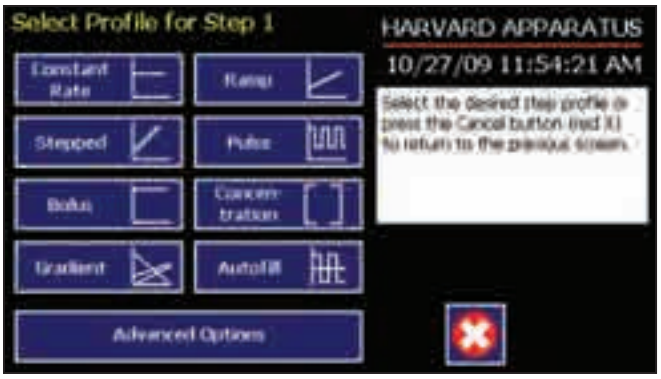
The PHD ULTRA™ Pumps are available in three configurations designed for different operating environments and varying degrees of operational flexibility.

Infusion Only: This model supports infusion operations at user-defined flow rates and with selectable target volume or time values to control the total infusion volume. The Infusion Only models do not include programmable, user-defined Methods.

Infusion/Withdrawal: This model supports infuse only, withdraw only, infuse/withdraw and withdraw/infuse operations at user-defined flow rates and with selectable target volume or time. Users can create and store one Method up to 800 steps.

Infusion/Withdrawal Programmable: This model supports infuse only, withdraw only, infuse/withdraw and withdraw/infuse operations. Users can create and store multiple Methods of up to 800 steps on the pump.

PHD ULTRA™ Advanced Syringe Pumps (continued)



Program Description

To operate the PHD ULTRA™, the user defines all the required parameters for infusing and/or withdrawing liquids through a Method. This may be a Quick Start, Pre-Programmed or User-Defined Method. The basic operation is a simple 3-step procedure:

1. **Select a Method**
2. **Enter operating parameters**
3. **Preview or Run your Method**

Quick Start Methods are for simple infusions, withdrawals or a combination (depending on the pump model). Custom user-defined Methods can be created when a more advanced Method is required. The setup for a custom Method is easy using the standard profiles found on all Infusion/Withdrawal and Infusion/Withdrawal Programmable PHD ULTRAS. The list of available profiles are:

Constant Rate	Bolus	Pulse
Ramp	Concentration	Autofill
Stepped	Gradient	

By programming and saving custom Methods in the pump, multi-user errors are reduced. Easily transfer complex methods to other pumps and/or download methods from a PC. Forget having to duplicate method-development efforts for each new pump added to your system.

In addition to the advanced pumping profiles listed above, the PHD ULTRA™ contains a variety of advanced options allowing the user to repeat steps, link methods, control valves, external triggers etc.

Advanced Programming Features

Flow Programming: *Change the flow with time, volume or a triggered event as many times as you like.*

Bolus: *Inject a large volume of drug (or drugs) at once. The bolus injection can be made in time or volume.*

Concentration Delivery: *Calibrate flow in concentration units of mg/kg easily so flow is calibrated to concentration of drug and animal weight.*

Gradients: *EZ PRO software allows you to easily program gradients, continuous or stepped.*

% Ratio: *Up to three solvents.*

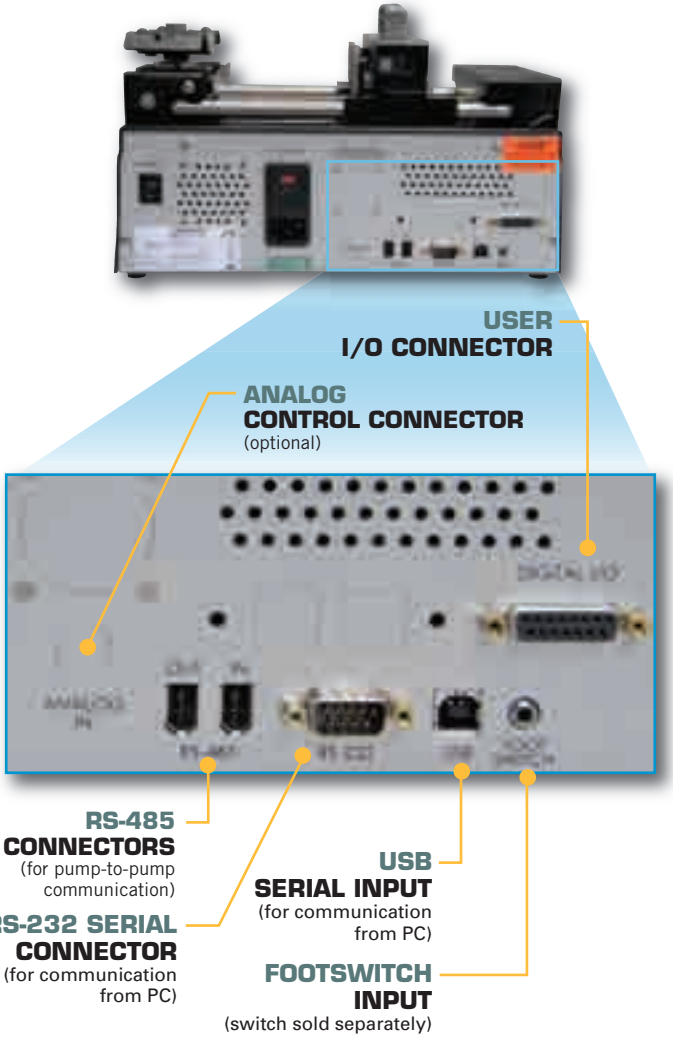
I/O: *Dedicated and user defined I/O.*

Pulsed Flow: *So you can program the pulse easily.*

Advanced Connectivity

All PHD ULTRA™ Syringe Pumps come standard with a footswitch, USB, RS-232, RS-485 and I/O connectors. There is also an option for RJ-11 connectors and analog control. These options have to be ordered at the time the pump is ordered.

FOOTSWITCH INPUT	Start and stop a pump
USB AND RS-232 SERIAL INPUTS	Control your pump with a computer
RS-485 CONNECTORS	Connect multiple pumps together (up to 99)
	Connect remote mechanism
	Connect satellite pumps to the Master pump for binary or ternary gradient system (% composition)
RJ-11 CONNECTORS (OPTION)	Connect multiple pumps together (daisy chain)
USER I/O CONNECTOR	
Direction Control input	Set pump to infuse or withdraw
Trigger Input	Connect and external device to start or stop a pump or Method
Footswitch Input	Start and stop a pump
Trigger 1 Output	Signal another device to start and stop a pump or Method
Trigger 2 Output	Signal another device to start and stop a pump or Method
Sync Output	Synchronize other devices
Valve Output	External valve control
Run Indicator	Connect an external LED or monitoring device to a pump
ANALOG CONTROL (OPTIONAL)	Analog control of the motor speed (0 to 10 V). This option must be ordered at the same time the pump is ordered.



PHD ULTRA™ Advanced Syringe Pumps (continued)

Alarms

There are several alarms available on the PHD ULTRA™ Syringe Pumps.

End of Run, Near End of Run, Power Up, Stall, Calibration Reminder

You may choose to activate one, activate them all or mute them all.

Advanced GLP Documentation Features

- **Download experimental parameters to PC**
- **Alpha/Numeric capability**

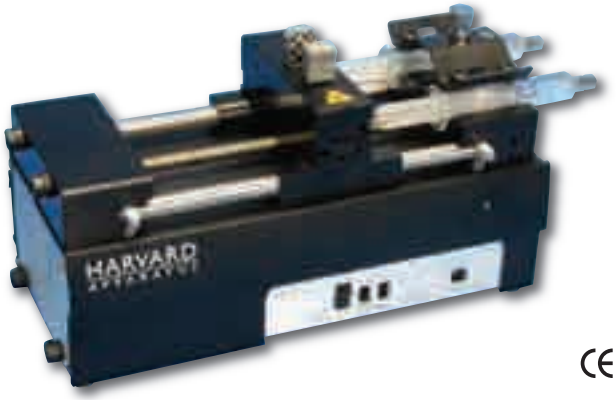
Upgrade

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

Accessories

A full range of accessories are compatible with the PHD ULTRA™ including syringe heaters, in-line heaters and coolers, microfluidic circuits, connectors, tubing, syringes and more.

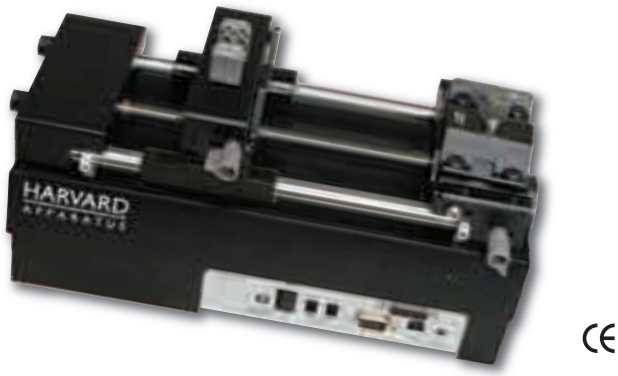
PHD ULTRA™ Satellite Pumps



PHD ULTRA™ Satellite Pumps

Th PHD ULTRA™ Satellite Pumps are infusion/withdrawal pumps. They are available in three configurations: standard, push/pull and high force. The Satellite Pumps are combined with stand alone PHD ULTRA™ Pumps to create a Gradient System. Satellite Pumps can only be powered from a stand alone PHD ULTRA™ via RS-485. They cannot be controlled with a PC. Satellite Pumps include a footswitch input, USB and RS-485 connectors. See page 22 for part numbers.

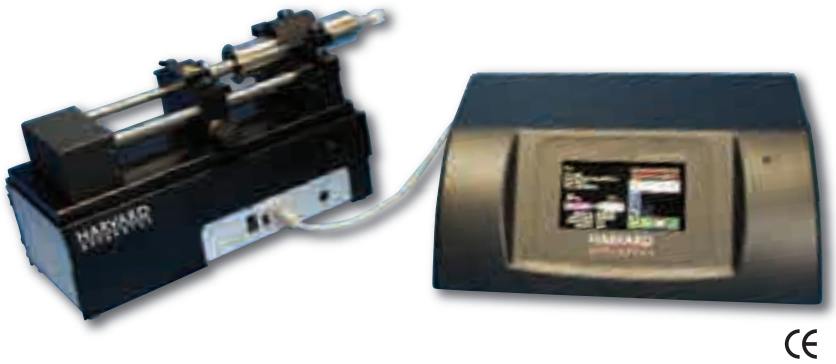
PHD ULTRA™ Syringe Pump Modules



PHD ULTRA™ Syringe Pump Modules

The PHD ULTRA™ Syringe Pump Modules are infusion/ withdrawal pumps. They are available in three configurations: standard, push/pull and high force. These modules include a footswitch input, USB, RS-232, RS-485 and I/O connectors. They can be controlled via PC. You can also start and stop a pump using the 15-pin user I/O connector. See Advanced Connectivity on page 20 for more information. See page 22 for part numbers.

PHD ULTRA™ Remote Pumps



PHD ULTRA™ Remote Pumps

The PHD ULTRA™ Remote Pumps consist of a control unit and syringe pumping mechanism all connected via a 30 foot RS-485 (IEEE-1394) cable. Every version of the PHD ULTRA™ is available in a remote model. Use the remote pump in hazardous environments where the researcher is safer when distanced from the material being pumped or for applications where it is necessary to have your pump inside an incubator. See page 22 for part numbers.

PHD ULTRA™ Advanced Syringe Pumps (continued)

PHD ULTRA™ Specifications	
TYPE	Microprocessor multiple syringe, infusion only, infusion/withdrawal or infusion/withdrawal programmable
ACCURACY	±0.25%
REPRODUCIBILITY	±0.05%
SYRINGES:	
Type	Plastic, glass or stainless steel
Size Minimum	0.5 µl
Size Maximum	140 ml
FLOW RATE:	
Minimum	1.50 pl/min
Maximum	216.0 ml/min
DISPLAY	4.3" WQVGA TFT color display with touchscreen
CONNECTORS:	
RS-232	9-pin D-Sub Connector
RS-485	6-position IEEE-1394
USB	Type B
I/O & TTL	15-pin D-Sub Connector
Footswitch	Phono jack
LINEAR FORCE	34 kg (75 lbs) @ 100% force selection
STEP RESOLUTION	0.082 µm/µstep
VOLTAGE RANGE	Universal input 100/240 VAC, 50/60 Hz
DIMENSIONS, H x W x D	10.16 x 30.48 x 21.59 cm (4 x 12 x 8.5 in)
WEIGHT	4.5 kg (10 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

Product	Order #	Order #	Order #	Order #
PHD ULTRA™ Standard	**Stand Alone**	**Remote**	**Satellite***	**Syringe Pump Module**
PHD ULTRA™ Infusion Only	**PC2 70-3005**	**PC2 70-3305**	–	–
PHD ULTRA™ Infusion/Withdrawal	**PC2 70-3006**	**PC2 70-3306**	**PC2 70-3406**	**PC2 70-3506**
PHD ULTRA™ Infusion/Withdrawal Programmable	**PC2 70-3007**	**PC2 70-3307**	–	–
PHD ULTRA™ Push/Pull	**Stand Alone**	**Remote**	**Satellite***	**Syringe Pump Module**
PHD ULTRA™ Push/Pull Infusion/Withdrawal	**PC2 70-3008**	**PC2 70-3308**	**PC2 70-3408**	**PC2 70-3508**
PHD ULTRA™ Push/Pull Infusion/Withdrawal Programmable	**PC2 70-3009**	**PC2 70-3309**	–	–
PHD ULTRA™ High Pressure	**Stand Alone**	**Remote**	**Satellite***	**Syringe Pump Module**
PHD ULTRA™ 4400 Pump I/W Programmable	**PC2 70-3010**	**PC2 70-3310**	**PC2 70-3410**	**PC2 70-3510**
PHD ULTRA™ HPSI Remote Pump I/W Programmable	–	**PC2 70-3111**	–	–
PHD ULTRA™ HPSI Remote Pump I/W Programmable with 10 x 140 Rack	–	**PC2 70-3112**	–	–
PHD ULTRA™ XF Remote I/W Programmable	–	**PC2 70-3314**	–	**PC2 70-3514**

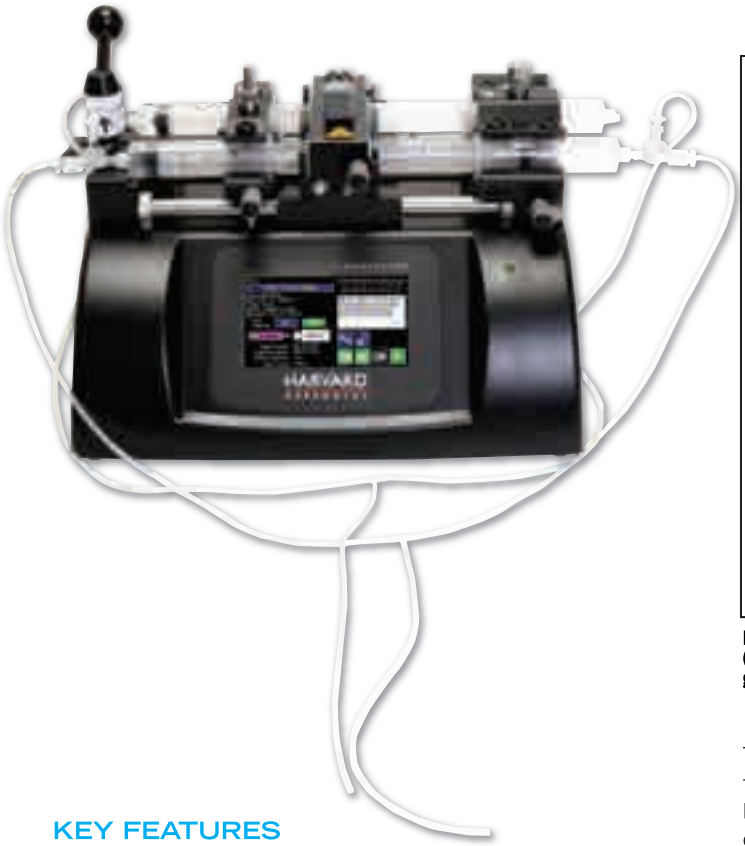
**Note: Gradient Systems are available, see page 24 for details.*

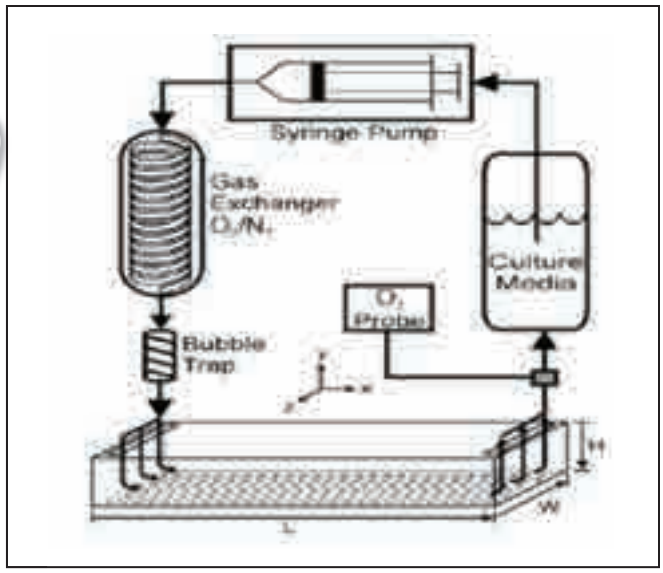
Order #	Product
PHD ULTRA™ Options and Kits	
PC2 70-3030	RS-232 RJ-11 Connectors Option (daisy chain)
PC2 70-3033	Analog Control Input Option (0-10 V)[2]
PC2 70-3034	Internal Fan Option[3]
PC2 70-3023	Anti-Siphon Kit for PHD ULTRA™
PHD ULTRA™ Syringe Rack Kits Ordered without a Pump	
PC2 70-3024	6/10 Multi-Syringe Rack for PHD ULTRA™, independently holds 10 syringes
PC2 70-3021	4 x 140 Multi-Syringe Rack for PHD ULTRA™
PC2 70-3022	Microliter Rack for PHD ULTRA™, independently holds 4 syringes
PHD ULTRA™ Syringe Rack Kits Ordered with a Pump	
PC2 70-3024A	6/10 Multi-Syringe Rack for PHD ULTRA™, independently holds 10 syringes
PC2 70-3021A	4 x 140 Multi-Syringe Rack for PHD ULTRA™
PC2 70-3022A	Microliter Rack for PHD ULTRA™, independently holds 4 syringes
PHD ULTRA™ Upgrades	
PC2 70-4010	Upgrade Infusion Only to I/W[1]
PC2 70-4011	Upgrade Infusion Only to Programmable[1]
PC2 70-4012	Upgrade I/W to Programmable[1]

[1] Note: Requires Return to Factory
[2] Note: Only for Programmable Models. Not available on Satellite Boxes.
[3] Note: Fan option is required if external operating ambient is expected to be >35°C

Accessories	
PC2 70-4000	RS-485 Cable for Pump-to-Pump Communication, 0.5 m (1.6 ft)
PC2 70-4001	RS-485 Cable for Pump-to-Pump Communication, 2 m (6.6 ft)
PC2 70-4020	RS-485 Extension Cable, 9.1 m (30 ft)
PC2 70-4002	USB Cable for PC-to-Pump Communication, 2 m (6.6 ft)
PC2 70-4003	USB Cable for PC-to-Pump Communication, 5 m (16.4 ft)
PC2 70-4004	RS-232 Cable for PC-to-Pump Communication, 9-pin D-sub, 2 m (6.6 ft)
PC2 70-4005	Adapter, PHD Digital I/O
PC2 70-4006	Adapter, D-sub 15 to Term. Blk
PC2 72-8340	Adapter, USB to Serial
PC2 70-2215	Footswitch (with Phono Plug)
PC2 55-7010	Auto Fill Valve Box, Low Pressure, 25 psi
PC2 55-0121	Auto Fill Valve Box, Medium Pressure, 100 psi
PC2 55-7008	Auto Fill Valve Box, High Pressure, 200 psi
PC2 55-7760	Cable Assy, Daisy-chain, Legacy RS-232 RJ-11, 0.6 m (2 ft)
PC2 72-2478	Cable Assy, Daisy-chain, Legacy RS-232 RJ-11, 2.1 m (7 ft)
PC2 55-8000	Plunger Adapter for 25 ml, 50 ml, 100 ml Hamilton GasTight™ Syringes

PHD ULTRA™ Push/Pull Syringe Pump





Pressure-driven flow was continuous using a programmable push-pull syringe pump (Harvard Apparatus, Holliston, MA). Media was equilibriated with 10% or 21% O_2 in a gas exchanger made with gas-permeable silastic tubing[1].

KEY FEATURES

- **Compensating Flows: The control of continuous infusion and simultaneous withdrawal of liquids while monitoring fluid levels**
- **Perfusion Across Tissue Beds: Directional control of flows across tissue beds using switching valves**
- **Continuous Flow with High Accuracy and Smooth Flow: Pump Any Volume Large or Small with Smooth, Non Pulsating Flow**
- **Continuous Accurate Flow for High Pressure Systems: Unlike peristaltic pumps, syringe pumps can pump against high pressures**
- **Easily Sterilized Flow Path: By replacing syringe and tubing with a sterilized set, this pump can maintain it's sterility**

PHD ULTRA™ Push/Pull References

High-density cell seeding of myocyte cells for cardiac tissue engineering, Radisic et. al., 2008, Biotechnology and Bioengineering, Volume 82, Issue 4

Fabrication of 3D hepatic tissues by additive photopatterning of cellular hydogels, Tsang et. al., 2007, FASEB, Volume 21

[1]Formation of Steady-State Oxygen Gradients In Vitro, Application to Liver Zonation Allen et. al., 2003, Biotechnology and Bioengineering, Volume 82, No 3

The PHD ULTRA™ Push-Pull syringe pump provides virtually pulse free, high accuracy and high precision flow. Complex programs can be written using on-board EZ Pro software to reduce shear stress during cell deposition and adhesion during tissue and organ development. Conversely, the same complex programs can be used to create particular shear forces on developing cells.

The PHD ULTRA™ Push Pull combines the high accuracy of our ULTRA line of pumps. Harvard Apparatus also has a wide array of temperature control products to provide complete environmental control. Our 2 year warranty and robust construction allow these pumps to work continuously for extended periods of time with unsurpassed reliability.

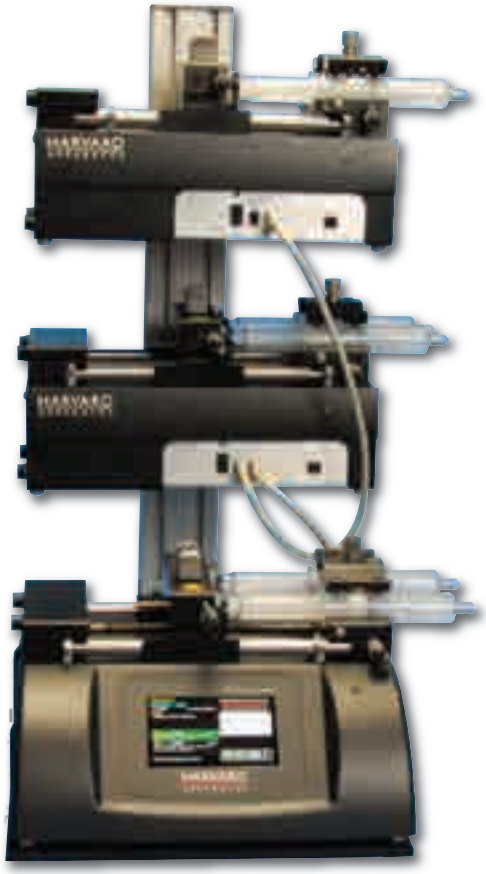
For complete specifications see facing page.

Order #	Product
PC2 70-3009	PHD ULTRA™ Push-Pull Programmable Syringe Pump
PC2 61-0270	Continuous Flow Tubing Segment

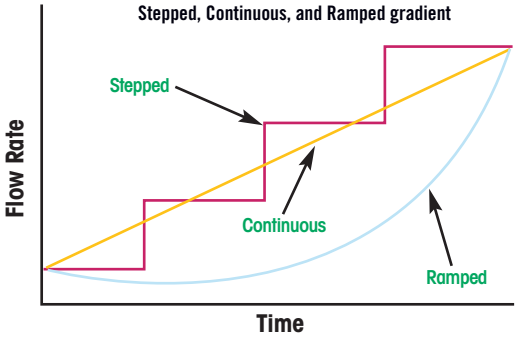
**Note: For full product offering please see page 22.*

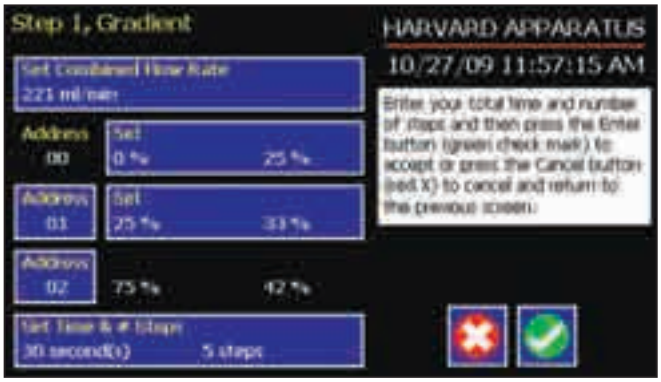
Watch a video demonstration of a PHD ULTRA™ Push-Pull Programmable Syringe Pump. To view press release, use your smart phone to scan the QR code or to view in a web browser go to http://tinyurl.com/44to6pv

Mixture/Dose Delivery System



PC2 70-4102
PHD ULTRA™
Gradient System
with Stand





KEY FEATURES

- Easily run binary or ternary gradients without a PC
- Combine multiple flow streams into one common output
- No stopping experiment to fill syringes with different mixtures

APPLICATIONS

- Serial Dilutions of reaction dosing solutions
- Serial Dilutions for drug infusion experiments
- Serial Dilutions for nutritional infusion experiments
- Serial Dilutions for mixing polymers in electrospinning
- Chromatography
- FIA systems

The PHD ULTRA™ Gradient Systems allows you to quickly and easily run binary or ternary mixtures automatically without a PC. The Method is totally programmed from a master controller pump, for easy set-up. The intuitive program interface makes simple to complex mixing easy. The Gradient Profile is used to combine multiple flow streams from different pumps into a common output stream. The flow can be smooth and continuous or stepped. No stopping the experiment, mixing different % volume mixtures and placing new syringes into the pumps. Push one button and it all happens automatically.

Binary and ternary gradient systems are available with or without a stand. Individual Satellite units are also available for purchase separately.

For more information on the PHD ULTRA™ Syringe Pumps see page 18-22. For more information on the PHD ULTRA™ Satellite units see page 21.

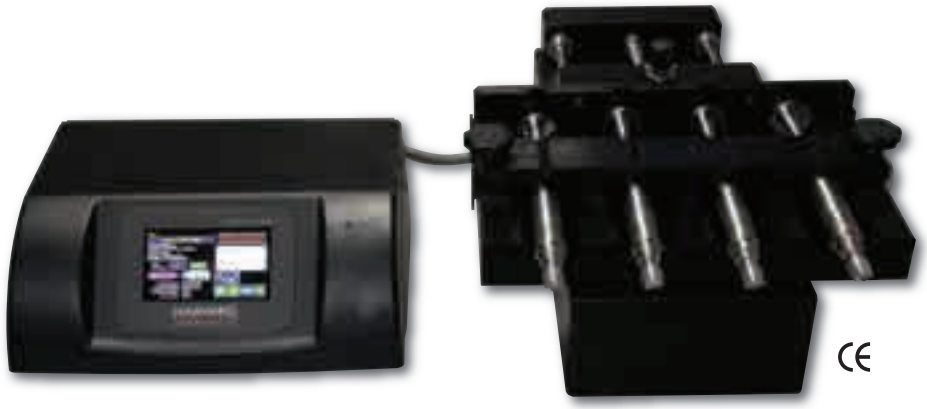
Mix/Dose Delivery System Specifications

TYPE	Microprocessor multiple syringe, infusion only, infusion/withdrawal or infusion/withdrawal programmable
ACCURACY	±0.25%
REPRODUCIBILITY	±0.05%
SYRINGES:	
Type	Plastic, glass or stainless steel
Size Minimum	0.5 µl
Size Maximum	140 ml
FLOW RATE:	
Minimum	1.50 pl/min
Maximum	216.0 ml/min
DISPLAY	4.3" WQVGA TFT Color Display with Touchpad
CONNECTORS:	
RS-232	9-pin D-Sub Connector
RS-485	6-position IEEE-1394
USB	Type B
I/O & TTL	15-pin D-Sub Connector
Footswitch	Phono jack
LINEAR FORCE	34 kg (75 lbs) @ 100% force selection
STEP RESOLUTION	0.082 µm/µstep
VOLTAGE RANGE	Universal input 100/240 VAC, 50/60 Hz
DIMENSIONS, H x W x D	10.16 x 30.48 x 21.59 cm (4 x 12 x 8.5 in)
WEIGHT	4.5 kg (10 lbs)
CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

Order #	Product
PC2 70-4101	PHD ULTRA™ Gradient System 1 Master/1 Satellite with Stand
PC2 70-4102	PHD ULTRA™ Gradient System 1 Master/2 Satellites with Stand
PC2 70-4106	PHD ULTRA™ Gradient System 1 Master/1 Satellite without Stand
PC2 70-4107	PHD ULTRA™ Gradient System 1 Master/2 Satellites without Stand

**High Force and Push-Pull Gradient Systems are available.*

NEW PHD ULTRA™ XF and PHD ULTRA™ HPSI



KEY FEATURES: PHD ULTRA™ XF

- Pump up to 800 ml with four 200 ml syringes
- Ultra high pressure – delivers over 400 lbs of pumping force (HPSI Model)
- Ultra high pressure – delivers 1000 lbs of pumping force (XF Model)
- Intuitive touch screen with icon interface
- Easily program simple to complex Methods without a PC

APPLICATIONS

- High Pressure Injections
- Drug Delivery
- Pumping Highly Corrosive Fluids
- Injecting into High Pressure Reaction Vessels
- Remote pumping of Hazardous Material

The PHD ULTRA™ HPSI and PHD ULTRA™ XF pumps are infusion/withdrawal programmable syringe pumps that hold four stainless steel syringes ranging from 20 ml to 200 ml. These high pressure pumps deliver over 400 lbs and 1000 lbs of pumping force respectively. The PHD ULTRA™ HPSI and PHD ULTRA™ XF syringe pumps are ideal for high pressure applications or for pumping large volumes.

The PHD ULTRA™ HPSI Syringe Pump consists of a control unit, a syringe pumping mechanism and a 5 foot (1.5 m) cable to connect the two units. Although stainless steel syringes are recommended, this pump includes mounting brackets for plastic syringes.

The PHD ULTRA™ XF Syringe Pump consists of a control unit, a syringe pumping mechanism and a 30 foot (9.1 m) cable to connect the two units.

PHD ULTRA™ XF and HPSI Remote Specifications	
TYPE	Microprocessor multiple syringe, infusion/ withdrawal or infusion/withdrawal programmable
ACCURACY	±0.50%
REPRODUCIBILITY	±0.05%
SYRINGES:	
PHD ULTRA™ XF	20 ml to 200 ml (stainless steel only)
PHD ULTRA™ HPSI	PC2 70-3111: 20 ml to 200 ml (stainless steel) PC2 70-3112: 60 ml or 140 ml (plastic syringes only)
FLOW RATE:	
Minimum	50.79 nl/min (using 20 ml syringe)
Maximum	144.3 ml/min (using 200 ml syringe)
DISPLAY	4.3" WQVGA TFT color display with touchscreen
CONNECTORS:	
RS-232	9-pin D-Sub Connector
RS-485	6-position IEEE-1394
USB	Type B
I/O & TTL	15-pin D-Sub connector
Footswitch	Phono jack
AVERAGE LINEAR FORCE:	
PHD ULTRA™ XF	454 kg (1000 lbs) @ 100% force selection
PHD ULTRA™ HPSI	196 kg (433 lbs) @ 100% force selection
STEP RESOLUTION	0.082 µm/step
VOLTAGE RANGE	Universal input 100/240 VAC, 50/60 Hz
DIMENSIONS, H x W x D	10.16 x 30.48 x 21.59 cm (4 x 12 x 8.5 in)
DIMENSIONS (CONTROL BOX)	30.48 x 21.59 x 10.8 cm (12 x 8.5 x 4.25 in)
DIMENSIONS (REMOTE BOX)	40.64 x 30.48 x 19.69 cm (16 x 12 x 7.75 in)
WEIGHT	13.7 kg (30.2 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

Order #	Product
PC2 70-3111	PHD ULTRA™ HPSI Remote Infusion/Withdrawal Programmable Syringe Pump
PC2 70-3112	PHD ULTRA™ HPSI Remote Infusion/Withdrawal Programmable Syringe Pump with 10 x 140 Rack
PC2 70-3314*	PHD ULTRA™ XF Remote Infusion/Withdrawal Programmable Syringe Pump
PC2 70-3030	PHD ULTRA™ RS-232 and RJ-11 Connectors Option
PC2 70-3033	PHD ULTRA™ Analog Control Input Option (0-10 VDC)

** Note: XF Pump also available as a Syringe Pump Module (PC2 70-3514).*

Standard mounting is for stainless steel syringes. Inquire for mounting brackets for plastic syringes

PHD ULTRA™ 4400

PHD ULTRA™ 4400
Stand-Alone

KEY FEATURES

- 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 touch screen and icon interface
- Program simple to complex Methods without a PC
- Legendary reliability – 2 year warranty

APPLICATIONS

- High Pressure Injections
- Drug Delivery
- Pumping Highly Corrosive Fluids
- Injecting into High Pressure Reaction Vessels
- Remote pumping of Hazardous Material

The PHD ULTRA™ 4400 is a single syringe infusion/withdrawal programmable syringe pump. This pump allows you to create, save and run simple to complex Methods without a PC or just enter a flow rate and run. The flow rate range is 3.06 pl/min to 216.0 ml/min with 200 lbs of adjustable force across the entire flow rate range. For more information on the PHD ULTRA™ 4400 including features and programming see page 26.

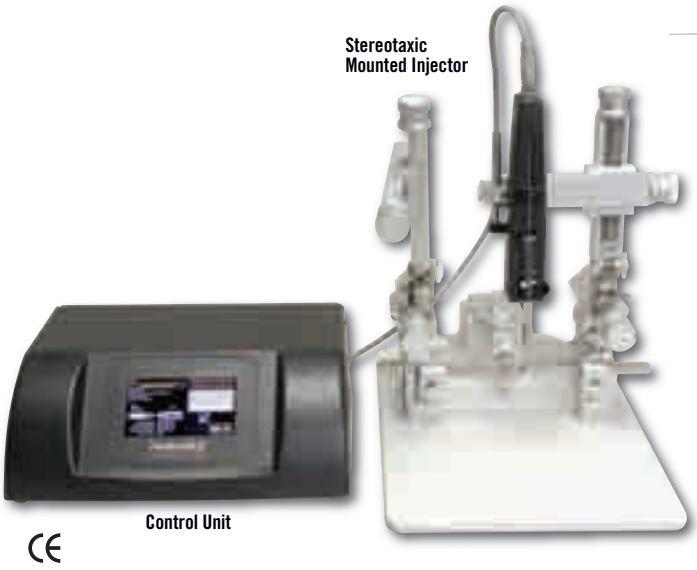
The PHD ULTRA™ 4400 pump is ideal for high pressure applications. This pump is available in two configurations: stand-alone and remote. The remote model consists of a control unit, a syringe pumping mechanism and a 5 foot cable to connect the two units.

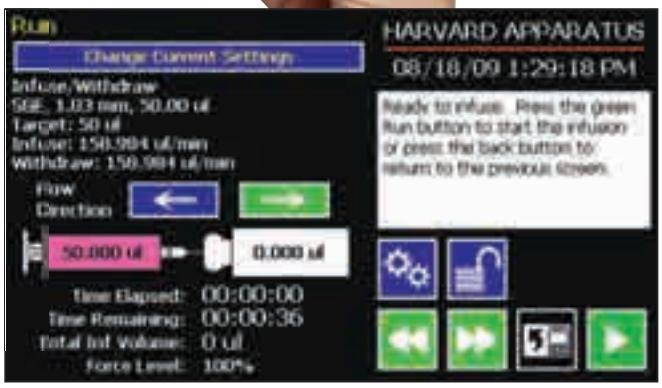
The PHD ULTRA™ 4400 has a footswitch input, RS-232 and USB serial ports for computer control, RS-485 ports for daisy chaining pumps and Digital I/O for external control via an independent computer or device. There is also an option for daisy chaining pumps through the RS-232 (RJ-11) ports. This option must be ordered at the time the pump is ordered. See page 26 for more information on connectivity.

Specifications	PHD ULTRA™ 4400 Stand-Alone	PHD ULTRA™ 4400 Remote
TYPE	Microprocessor single syringe infusion/withdrawal programmable	Microprocessor single syringe infusion/withdrawal programmable
ACCURACY	±0.35%	±0.35%
REPRODUCIBILITY	±0.05%	±0.05%
SYRINGES		
Type	Glass, Plastic or Stainless Steel	
Size Minimum	0.5 µl	0.5 µl
Size Maximum	140 ml	140 ml
FLOW RATE:		
Minimum	3.06 pl/min	3.06 pl/min
Maximum	216.0 ml/min	216.0 ml/min
DISPLAY	4.3" WQVGA TFT color display with touchscreen	
CONNECTORS:		
RS-232	9-pin D-Sub Connector	9-pin D-Sub Connector
RS-485	IEEE-1394, 6 pos	IEEE-1394, 6 pos
USB	Type B	Type B
I/O & TTL	15-pin D-Sub Connector	15-pin D-Sub Connector
Footswitch	Phono jack	Phono jack
AVERAGE LINEAR FORCE	91 kg (200 lbs) @ 100% Force Selection	91 kg (200 lbs) @ 100% Force Selection
STEP RESOLUTION	0.164 µm/µstep	0.164 µm/µstep
VOLTAGE RANGE	Universal input 100/240 VAC, 50/60 Hz, 50 W, 0.5 A fuse	Universal input 100/240 VAC, 50/60 Hz, 75 W, 0.5 A fuse
DIMENSIONS, H x W x D:		
Control Box	30.48 x 21.59 x 18.4 cm (12 x 8.5 x 7.25 in)	30.5 x 21.6 x 10.8 cm (12 x 8.5 x 4.25 in)
Remote Box	N/A	27.9 x 13.5 x 18.4 cm (11.0 x 5.3 x 7.25 in)
WEIGHT	5.5 kg (12.1 lbs)	6.4 kg (14.1 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS and CB Scheme	
Order #	**PC2 70-3010**	**PC2 70-3310**

Accessories	
PC2 70-4000	RS-485 Cable for Pump-to-Pump Communication, 0.5 m (1.6 ft)
PC2 70-4021	RS-485 Cable for Pump-to-Pump Communication, 1 m (3.3 ft)
PC2 70-4001	RS-485 Cable for Pump-to-Pump Communication, 2 m (6.6 ft)
PC2 70-4002	USB Cable for PC-to-Pump Communication, 2 m (6.6 ft)
PC2 70-4003	USB Cable for PC-to-Pump Communication, 5 m (16.4 ft)
PC2 70-4004	RS-232 Cable for PC-to-Pump Communication, 9-pin D-sub, 2 m (6.6 ft)
PC2 70-4020	RS-485 Cable (IEEE-1394) Remote Extension Cable, 9.1 m (30 ft)
PC2 70-4005	Adapter, PHD Digital I/O
PC2 72-4006	Adapter, D-sub 15 to Term, Blk
PC2 70-3315	Footswitch (with Phono Plug)
PC2 55-7760	Cable Assy, Daisy-chain, Legacy RS-232 RJ-11, 0.6 m (2 ft)
PC2 72-2478	Cable Assy, Daisy-chain, Legacy RS-232 RJ-11, 2.1 m (7 ft)

PHD ULTRA™ Nanomite





KEY FEATURES

- Light weight makes it ideal for hand-held or stereotaxic injection
- Easy-to-use LCD color touch screen with GUI interface
- Create and store >50 programs for
- High performance in a small package
- 1000 times better than manual syringes

APPLICATIONS

- Cellular Injections
- Drug Delivery
- Microinjections
- Hand-Held Automated Delivery
- Stereotaxic Injections
- Regenerative Medicine

The PHD ULTRA™ Nanomite is a single syringe infusion/withdrawal programmable syringe pump. This pump allows you to create, save and run simple to complex Methods without a PC. The flow rate range is 3.66 pl/min to 3.82 ml/min with 11 lbs of adjustable force across the entire flow rate range.

The PHD ULTRA™ Nanomite has a footswitch input, RS-232 and USB serial ports for computer control, RS-485 ports for daisy chaining pumps and Digital I/O for external control via an independent computer or device. There is also an option for daisy chaining pumps through the RS-232 (RJ-11) ports. This option must be ordered at the time the pump is ordered. See page 20 for more information on connectivity.

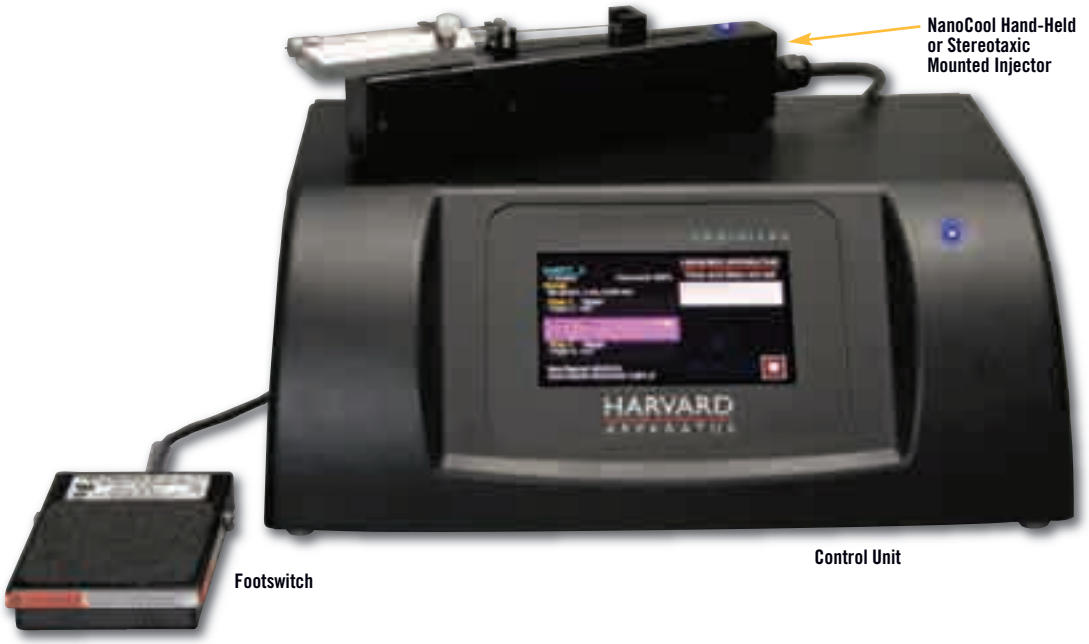
This pump consists of a control unit, an injection unit, a 6 foot cable to connect the two units and a footswitch.

For more information on the PHD ULTRA™ Nanomite including features and programming see the PHD ULTRA™ on page 18.

PHD ULTRA™ Nanomite Specifications	
TYPE	Microprocessor single syringe Infusion/Withdrawal Programmable
ACCURACY	±0.5%
REPRODUCIBILITY	±0.05%
SYRINGES:	
Type	Glass or plastic
Size Minimum	0.5 µl
Size Maximum	1 ml
FLOW RATE:	
Minimum	3.66 pl/min
Maximum	3.82 ml/min
DISPLAY	4.3" WQVGA TFT color display with touchscreen
CONNECTORS:	
RS-232	9-pin D-Sub Connector
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15-pin D-Sub Connector
Footswitch	Mini phono jack
AVERAGE LINEAR FORCE	5 kg (11 lbs) @ 100% force selection
STEP RESOLUTION	0.198 µm/µstep
VOLTAGE RANGE	100-240 VAC, 50/60 Hz, 75 W, 0.5 A fuse
DIMENSIONS H x W x D:	
Control Box	30.5 x 21. 6 x 11.1 cm (12.0 x 8.5 x 4.38 in)
Injector Unit	6.35 x 5.08 x 19.05 cm (2.5 x 2.0 x 7.5 in)
WEIGHT:	
Control Box	2.06 kg (4.55 lbs)
Injector Unit	0.458 kg (1.01 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS and CB Scheme

Order #	Product
PC2 70-3601	PHD ULTRA™ Nanomite Infusion/Withdrawal Programmable Single Syringe

NanoCool™ Injector



KEY FEATURES

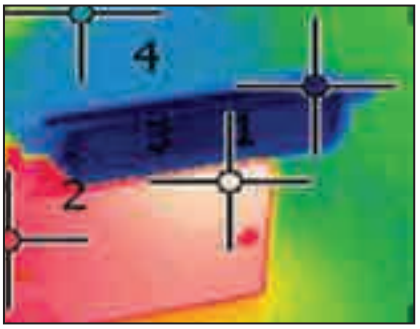
- 18ºC for optimal cell viability on any delivery syringe and Eppendorf
- 20% Increase in Survivability, 76% Lower O_2 Consumption Rate at 18ºC vs. 37ºC
- Flow ramping to reduce injection site blowback
- Programmed methods for automatic recall of entire cell delivery system. Up to 100 methods stored for recall
- 2 year warranty
- High accuracy delivery between 3.66 pl/min to 1.91 ml/min
- Preprogrammed bolus injection mode, just specify injection size and time of dispense
- Footswitch activation keeps hands free

NanoCool™ Cell Delivery System

When injecting stem cells viability of cells can be a major issue. The injection system and sample vortex holder are held at 18ºC. The cell delivery is totally integrated in it operation through the NanoCool's microprocessor system: power, temperature injection volumes and flow ramping are all controlled by the NanoCool's program. Keeping the cells at 18ºC instead of 37ºC reduces O_2 consumption of cells by an average of 76%. The chart to the right shows the different organ utilization curves.

Temperature Effect on O_2 Consumption by Organ Cell Type

Organ	Temperature	Oxygen Consumption	Change in O_2 Consumption	% Change
Kidney	37 to 18	3.7 to 0.9	2.8	75.7
Liver	37 to 18	3.0 to 0.6	2.4	80
Heart	37 to 18	2.4 to 0.7	1.7	70.8
Brain	37 to 18	1.9 to 0.4	1.5	78.9
Muscle	37 to 18)	0.8 to 0.2	0.6	75
Skin	37 to 18	0.4 to 0.1	0.3	75



IR Temperature Image
NanoCool at 18°C

NanoCool™ Injector Specifications

ACCURACY	±0.5%
REPRODUCIBILITY	±0.05%
SYRINGES (MIN./MAX.)	50 µl / 500 µl
FLOW RATE:	
Minimum	3.66 pl/min
Maximum	1.91 ml/min
INJECTOR HEAD/ACTUATOR, L x H x W	20.3 x 5.1 x 5.1 cm (8 x 2 x 2 in)

Order #	Product
PC2 88-1050	NanoCool™ Injector

Pump 11 Plus

CE

KEY FEATURES

- Small footprint
- RS-232 option for computer control
- Legendary reliability – 2 year warranty

APPLICATIONS

- Drug/Nutritional Delivery
- Microfluidics/Nanofludics
- Electrospinning
- Mass Spec Calibration
- Microdialysis

Pump 11 Plus

Harvard Apparatus' Pump 11 Plus is a high performance smooth flow syringe pump at a basic syringe pump price!

Bright Display and Easy-To-Use Interface

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

Two Modes of Operation, Constant Flow Rate & Volume Dispense

The 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, Infusion Only or Infusion/Withdrawal. Both models are available with either a single syringe or dual syringe configuration.

Pump 11 Plus Specifications

TYPE	Microprocessor single or dual syringe, infusion only or infusion/withdrawal
ACCURACY	±0.5%
REPRODUCIBILITY	±0.1%
SYRINGE:	
Type	Plastic or glass
Size (single syringe)	0.5 µl to 50/60 ml
Size (dual syringe)	0.5 µl to 10 ml
FLOW RATE:	
Single Syringe	0.0014 µl/hr to 26.56 ml/min
Dual Syringe	0.0014 µl/hr to 7.91 ml/min
CONNECTORS:	
RS-232	Advanced models only
TTL	No
AVERAGE LINEAR FORCE	7.27 kg (16 lbs)
STEP RESOLUTION	0.33 µm/µstep
VOLTAGE RANGE (POWER SUPPLY)	Universal input 100/240 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 lbs)

Order #	Product
PC2 70-2208	Pump 11 Plus Infusion Only Single Syringe
PC2 70-2209	Pump 11 Plus Infusion Only Dual Syringe
PC2 70-2211	Pump 11 Plus Advanced Infusion/Withdrawal Single Syringe with Dual RS-232
PC2 70-2212	Pump 11 Plus Advanced Infusion/Withdrawal Dual Syringe with Dual RS-232

Pump 11 Plus References

Miguéns, M., et al., Glutamate and aspartate levels in the nucleus accumbens during cocaine self-administration and extinction: a time course microdialysis study, Psychopharmacology, 2008, Vol. 196, 303–313

Russom, A., et al., Microfluidic Leukocyte Isolation for Gene Expression Analysis in Critically Ill Hospitalized Patients, Clinical Chemistry, 2008, Vol. 54:5, 891–900

Choi, S. and Park, J., Microfluidic system for dielectrophoretic separation based on a trapezoidal electrode array, Lab on a Chip, 2005, Vol. 5, 1161–1167

Tan, YC., Li Ho, Y., and Phillip, A., Microfluidic sorting of droplets by size, Microfluid Nanofluid, 2008, Vol. 4, 343–348

Cucchiaro, G., Chaijale, N., and Commons, K.G., The locus coeruleus nucleus as a site of action of the antinociceptive and behavioral effects of the nicotinic receptor agonist, epibatidine, Neuropharmacology, 2006, Vol. 50, 769-776

Pump 22 and PHYSIO 22 Multiple Syringe Pumps

CE

KEY FEATURES

- Smooth and accurate flow
- Easy to use
- Versatile with wide flow rate range
- Multi-syringe racks for large reservoir capacity
- Legendary reliability – 2 year warranty

APPLICATIONS

- Drug/Nutritional Delivery
- Fluid Sampling
- Mass Spectrometry

Pump 22

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.

- **The standard 2-syringe rack holds 2 syringes from 0.5 µl to 140 ml**
- **The 4 x 140 multi-rack holds four 60 ml or 140 ml plastic syringes only**
- **6/10 multi-rack will hold up to 10 syringes from 0.5 µl to 20 ml and up to 6 syringes from 30 ml to 60 ml**
- **The microliter syringe rack independently holds 4 microliter syringes, from 0.5 µl to 10 ml, enabling syringes of different sizes to run simultaneously.**

This pump features an LED display and numeric 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 leadscrew 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 a footswitch, audible alarm, reversing switch and serial cables, see page 44.

The Pump 22 can be controlled using RS-232 (serial) commands. 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. The default setting is 0. A set of sample programs, using the basic programming language, is included with each pump.

PHYSIO 22

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

PHYSIO 22 (continued)

Syringe Pump 22, but with a special transformer designed for minimum RFI (Radio Frequency Interference). This new transformer cuts electrical noise so that it is almost non existent. With the PHYSIO 22, even the most sensitive sensors will not show a noise spike.

Pump 22 & PHYSIO 22 Specifications	
TYPE	Microprocessor multiple syringe, infusion only or infusion/withdrawal
ACCURACY	±0.35%
REPRODUCIBILITY	±0.05%
SYRINGE:	
Type	Plastic, glass or stainless steel
Size Minimum	0.5 µl
Size Maximum	140 ml
FLOW RATE:	
Minimum	0.002 µl/hr
Maximum	55.1 ml/min
CONNECTORS:	
RS-232	25-pin connector
TTL	Shared port with RS-232
AVERAGE LINEAR FORCE	21.36 (47 lbs)
STEP RESOLUTION	0.33 µm/µstep
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 lbs)

Order #	Product
PC2 55-2222	Pump 22 Infusion Only with Standard 2-Syringe Rack
PC2 55-2275	Pump 22 Infusion Only w/Anti-Siphon Standard 2-Syringe Rack*
PC2 55-5920	Pump 22 Infusion Only with 6/10 Multi-Syringe Rack
PC2 55-2314	Pump 22 Infusion Only with 4 x 140 Multi-Syringe Rack
PC2 55-4150	Pump 22 Infusion Only with Microliter Rack
PC2 55-2226	Pump 22 Infusion/Withdrawal with Standard 2-Syringe Rack
PC2 55-2219	Pump 22 Infusion/Withdrawal with 6/10 Multi-Syringe Rack
PC2 55-2316	Pump 22 Infusion/Withdrawal with 4 x 140 Multi-Syringe Rack
PC2 55-4153	Pump 22 Infusion/Withdrawal with Microliter Rack
PC2 70-2222	PHYSIO 22 Infusion Only with Standard 2-Syringe Rack
PC2 70-2223	PHYSIO 22 Infusion Only with 6/10 Multi-Syringe Rack

** Note: Anti-Siphon syringe holder secures syringe plunger to pusher block to prevent unintended loss of fluid*

Pump 22 References

Svoboda, K., et al., Conformation and elasticity of the isolated red blood cell membrane skeleton, Biophys. J., 1992, Vol 63, 784-793.

Jang, IK., Differential Sensitivity of Erythrocyte-Rich and Platelet-Rich Arterial Thrombi to Lysis With Recombinant Tissue-Type Plasminogen Activator: A Possible Explanation for Resistance to Coronary Thrombolysis, Circulation, 1989, Vol. 79, 920-928.

Gao, J., et al., Integrated Microfluidic System Enabling Protein Digestion, Peptide Separation, and Protein Identification, Anal. Chem., 2001, Vol. 73, 2648-2655

Jayawickrama, D.A., Wolters, A.M. and Sweedler, J.V., Mobile phase compensation to improve NMR spectral properties during solvent gradients, Analyst, 2003, Vol. 128, 421–426

Hiramatsu, M., et al., Reversion of muscarinic autoreceptor agonist-induced acetylcholine decrease and learning impairment by dynorphin A (1-13), an endogenous k-opioid receptor agonist, British Journal of Pharmacology, 1998, Vol. 123, 920-926

Pump 33 Dual Syringe Pump

KEY FEATURES

- Two independent pumping channels
- 2 syringes can run in the same or opposite direction, simultaneously
- Program different flow rates for each syringe
- Legendary reliability – 2 year warranty

BENEFITS

- Bulk Fluid Injections
- Drug Delivery
- Fluid Sampling
- Gradients
- Continuous Infusion

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 (page 44), 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.

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.

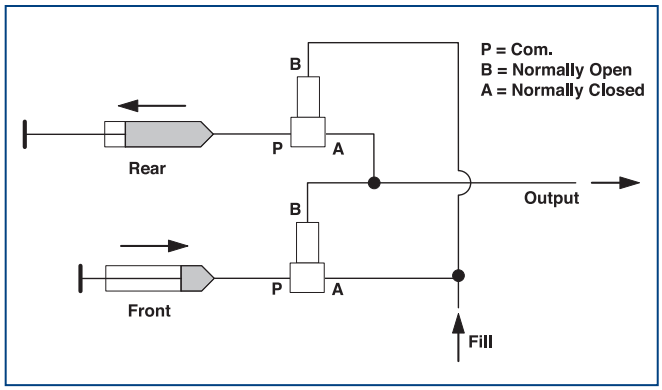
Reciprocal/Parallel Mode - Syringe mechanisms can run in the same or opposite directions (i.e. both infusing or withdrawing at the same time or one infusing and the other withdrawing)

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.

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



Valve Configuration for Continuous Flow

Pump 33 Specifications

TYPE	Microprocessor dual drive, single syringe, infusion/withdrawal
ACCURACY	±0.35%
REPRODUCIBILITY	±0.1%
SYRINGE:	
Type	Plastic, glass or stainless steel
Size Minimum	0.5 µl
Size Maximum	140 ml
FLOW RATE:	
Minimum	0.0004 µl/hr
Maximum	106.6 ml/min
CONNECTORS:	
RS-232	RJ11-4 conductor
TTL	9-pin connector
AVERAGE LINEAR FORCE	57 lbs
STEP RESOLUTION	0.33 µm/µstep
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 lbs)

Order #	Product
PC2 55-3333	Pump 33 Infusion/Withdrawal Dual Syringe

Pump 33 References

Chen, D., Wendt, C.H. and Pui, Y.H.D., A novel approach for introducing bio-materials into cells, Journal of Nanoparticle Research, 2000, Vol 2, 133–139

Cabrales, P., et al., Oxygen transport by low and normal oxygen affinity hemoglobin vesicles in extreme hemodilution, Am. J. Physiol. Heart Circ. Physiol., 2005, Vol. 288, H1885–H1892.

.Lee, S.H., et al., A polymer lab-on-a-chip for reverse transcription (RT)-PCR based point-of-care clinical diagnostics, Lab on a Chip, 2008, Vol. 8, 2121–2127

PHD 22/2000 Advanced Syringe Pumps

PHD 22/2000
Infusion/Withdrawal
with Standard
2-Syringe-Rack

PHD 22/2000
Infusion/Withdrawal
with 6/10 Multi-Rack

PHD 22/2000
Infusion Only
with Standard
2-Syringe Rack

PHD 22/2000
Push/Pull Syringe Pump

PC2 61-0270
Continuous Flow Tubing Segment

KEY FEATURES

- High accuracy and precision
- Multiple configuration available
- Smooth flow over a wide flow rate range
- Multi-syringe racks for large capacity reservoir
- Legendary reliability – 2 year warranty

APPLICATIONS

- Drug/Nutritional Delivery
- Electrospinning
- Microfluidics/Nanofluidics
- Mass Spec Calibration

Over forty years ago Harvard Apparatus perfected the leadscrew principle and created the first syringe pump. Since that time, tens of thousands of Harvard Apparatus pumps have earned a reputation as the most reliable research pumps in every major laboratory in the World. The PHD 22/2000 syringe pump series gives you the lowest flow rates, the highest accuracy, the smoothest flow, advanced programmability from the keypad and yet, is very easy to use. It is also incredibly quiet so it won't disturb your experimental subjects.

Configurations

This pump is available as a **standard, push/pull, remote, high pressure, or with multi-racks**.

Upgrade

We offer pumps that can be upgraded. If you buy an infusion/withdrawal pump and later decide you want programmability you can upgrade it, see page 33.

Syringe Racks

The PHD 22/2000 is offered with a variety of syringe racks to meet your specific application. Multi-syringe racks provide multi-channel operation or serve as a large capacity reservoir.

- **The push/pull syringe pump holds 4 syringes, 2 in each direction, for syringe sizes 0.5 µl to 140 ml***

Syringe Racks (continued)

- **The standard 2-syringe rack holds 2 syringes from 0.5 µl or 140 ml**
- **The 4 x 140 multi-rack holds four 60 ml or 140 ml plastic syringes only**
- **6/10 multi-rack will hold up to 10 syringes from 0.5 µl to 20 ml and up to 6 syringes from 30 ml to 60 ml**
- **The microliter syringe rack independently holds 4 microliter syringes, from 0.5 µl to 10 ml, enabling syringes of different sizes to run simultaneously**

PHD 22/2000 Specifications

TYPE	Microprocessor, multiple syringe, infusion only, infusion/withdrawal or infusion/withdrawal programmable
ACCURACY	±0.35%
REPRODUCIBILITY	±0.05%
SYRINGE:	
Type	Plastic, glass or stainless steel
Size Minimum	0.5 µl
Size Maximum	140 ml (30 ml for push/pull models)*
FLOW RATE:	
Minimum	0.0001 µl/hr
Maximum	220.82 ml/min
NON VOLATILE MEMORY	Stores all settings
CONNECTORS:	
RS-232	RJ11-4 conductor
TTL	9-pin D-Sub Connector
AVERAGE LINEAR FORCE:	
Standard	22.7 kg (50 lbs)
High Pressure	29.9 kg (66 lbs)
STEP RESOLUTION	0.082 µm/µstep
POWER	65 W, 0.5 A fuse
VOLTAGE RANGE	Universal input 100/240 VAC; 50/60 Hz
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 lbs)

**Push/Pull pump can hold syringes up to 140 ml if full stroke is not required. Larger syringes will not fully infuse or withdraw.*

PHD 22/2000 Advanced Syringe Pumps
(continued)

PHD 22/2000 Syringe Pumps

	Infusion Only*		Infusion/Withdrawal		Programmable	
SYRINGE PUMP VERSIONS	**Standard Force**	**High Force**	**Standard Force**	**High Force**	**Standard Force**	**High Force**
Standard Syringe Pumps						
STANDARD 2-SYRINGE	PC2 70-2000	PC2 71-2000	PC2 70-2001	PC2 71-2001	PC2 70-2002	PC2 71-2002
6/10 MULTI-RACK	PC2 70-2003	PC2 71-2003	PC2 70-2006	PC2 71-2006	PC2 70-2009	PC2 71-2009
4 X 140 MULTI-RACK	PC2 70-2004	PC2 71-2004	PC2 70-2007	PC2 71-2007	PC2 70-2010	PC2 71-2010
MICROLITER RACK	PC2 70-2005	PC2 71-2005	PC2 70-2008	PC2 71-2008	PC2 70-2011	PC2 71-2011
Remote Syringe Pumps						
STANDARD 2 SYRINGE	PC2 70-2100	PC2 71-2100	PC2 70-2101	PC2 71-2101	PC2 70-2102	PC2 71-2102
6/10 MULTI-RACK	PC2 70-2103	PC2 71-2103	PC2 70-2106	PC2 71-2106	PC2 70-2109	PC2 71-2109
4 X 140 MULTI-RACK	PC2 70-2104	PC2 71-2104	PC2 70-2107	PC2 71-2107	PC2 70-2110	PC2 71-2110
MICROLITER RACK	PC2 70-2105	PC2 71-2105	PC2 70-2108	PC2 71-2108	PC2 70-2111	PC2 71-2111
Push/Pull Syringe Pumps						
STANDARD	–	–	PC2 70-2020	PC2 71-2020	PC2 70-2019	PC2 71-2019
REMOTE	–	–	PC2 70-2120	PC2 71-2120	PC2 70-2119	PC2 71-2119

**Infusion Only models do not include an anti-siphon bracket or a retaining bracket. These can be ordered as a special.*

Harvard PHD 22/2000 Pump Series Kits & Upgrades

ORDER #	PRODUCT
Syringe Rack Kits[1]	
PC2 70-2012	PHD 22/2000 6/10 Multi Syringe Rack
PC2 70-2013	PHD 22/2000 4 x 140 Multi Syringe Rack
PC2 70-2014	PHD 22/2000 Microliter Multi Syringe Rack
PC2 70-2015	PHD 22/2000 Anti-Siphon Kit (Infusion Only Pump)
Upgrades[2]	
PC2 70-2016	PHD 22/2000 Infusion Only to Infusion/Withdrawal
PC2 70-2017	PHD 22/2000 Infusion/Withdrawal to Programmable
PC2 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 Infusion/Withdrawal models of PHD 22/2000 series pumps. All upgrades must be factory installed.*

Remote Extension Cables

Replacement cables for PHD 22/2000 Remote Syringe Pumps including the PHD 22/2000 Hpsi, see page 35, are available in 1.5 m (5 ft) and 9.1 m (30 ft) lengths. These cables can also be used to increase or decrease the distance between the syringe pumping mechanism and the control box.

Order #	Product
PC2 72-0199	Remote Extension Cable, 1.5 m (5 ft)
PC2 72-1405	Remote Extension Cable, 9.1 m (30 ft)

** Push/Pull pump can hold syringes up to 140 ml if full stroke is not required. Larger syringes will not fully infuse or withdraw. Max of 50 ml syringe if full stroke is required.*

Continuous Flow Tubing Segment

This continuous flow tubing segment is used with the PHD 22/2000 or PHD ULTRA™ Push/Pull Syringe Pumps. When used with the programmable model it makes continuous 24/7 flow possible.

Tubing Segment 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

Order #	Product
PC2 61-0270	Continuous Flow Tubing Segment

Pump 22/2000 References

Mazutis, L., et al., Droplet-Based Microfluidic Systems for High-Throughput Single DNA Molecule Isothermal Amplification and Analysis, Anal. Chem., 2009, Vol. 81, 4813-4821

Yeoma, J., et al., Microfabrication and characterization of a silicon-based millimeter scale, PEM fuel cell operating with hydrogen, methanol, or formic acid, Sensors and Actuators, 2005, Vol. B107, 882-891.

Guillot, P., et al., Towards a continuous microfluidic rheometer, Microfluid Nanofluid, 2008, Vol. 5, 619-630.

Utada, A.S., et al., Monodisperse Double Emulsions Generated from a Microcapillary Device, Science, 2005, Vol. 308, 537.

Liu Tsang, V., et al., Fabrication of 3D hepatic tissues by additive photopatterning of cellular hydrogels, FASEB Journal, 2007, Vol. 21, 790-801.

PHD 22/2000 MRI Compatible Syringe Pump

Syringe Holder

Control Box

KEY FEATURES

- High accuracy and precision
- Can be placed near an imaging magnet
- Holds 0.5 µl to 140 ml glass or plastic syringes
- Legendary reliability – 2 year warranty

BENEFITS

- Injecting Anesthesia
- Drug Delivery
- Injecting Dyes

The MRI Compatible Pump is based on the design of one of our most tried and trusted syringe pumps. The PHD 22/2000. This pump is made of mostly non-magnetic materials and can be placed near to an imaging magnet when it is in use! **The syringe pumping mechanism should be positioned at least 5 feet away from the opening of the magnet and not in direct line of the opening.** The exact distance is dependent upon the strength of the magnet. This will now make drug or dye perfusions possible while the magnet is on. This pump is a remote model where the syringe pumping mechanism is separated from the control box by a 30 foot cable. This allows the pump to be started and stopped near the magnet, via a RUN/STOP switch that was added to the syringe holder. If additional space is required between the control box and pumping mechanism, a 60 foot cable is also available. For more details on the PHD 22/2000 Pump line, see pages 32 to 35.

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 (infusion/withdrawal)**
- **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.

PHD 22/2000 Specifications	
TYPE	Microprocessor dual syringe infusion/withdrawal or infusion/withdrawal programmable
ACCURACY	±0.35%
REPRODUCIBILITY	±0.05%
SYRINGE:	
Type	Plastic or glass
Size Minimum	0.5 µl
Size Maximum	140 ml
FLOW RATE:	
Minimum	0.0001 µl/hr
Maximum	220.82 ml/min
NON VOLATILE MEMORY	Stores all settings
CONNECTORS:	
RS-232	RJ11-4 conductor
TTL	9-pin D-Sub Connector
AVERAGE LINEAR FORCE	22.7 kg (50 lbs)
STEP RESOLUTION	0.082 µm/µstep
VOLTAGE RANGE	Universal input 100/240 VAC, 50/60 Hz
CABLE LENGTH	9.1 m (30 ft)
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)

Order #	Product
PC2 70-2130	PHD 22/2000 MRI Compatible Remote Infusion/Withdrawal Dual Syringe
PC2 70-2131	PHD 22/2000 MRI Compatible Remote Infusion/Withdrawal Programmable Dual Syringe

PHD 22/2000 Hpsi and PHD 4400 Hpsi High Volume & Pressure Programmable Syringe Pumps

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

PHD 4400 Hpsi Programmable

KEY FEATURES

- Pump up to 800 ml with four 200 ml syringes
- High accuracy and reproducibility
- Rugged construction for a lifetime of service
- Accepts only Harvard Apparatus stainless steel syringes
- Legendary reliability – 2 year warranty

APPLICATIONS

- High Pressure Injections
- Drug Delivery
- Pumping Highly Corrosive Fluids
- Injecting into High Pressure Reaction Vessels

KEY FEATURES

- Accurate and smooth flow
- Easy-to-use interface
- RS-232 serial port for computer control
- Delivers over 200 lbs of pumping force across a wide flow rate range
- Legendary reliability – 2 year warranty

APPLICATIONS

- High Pressure Injections
- Drug Delivery
- Pumping Highly Corrosive Fluids
- Injecting into High Pressure Reaction Vessels

PHD 22/2000 Hpsi Specifications	
TYPE	Microprocessor multiple syringe, infusion/withdrawal programmable
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
RS-232	RJ11-4 conductor
TTL	9-pin D-Sub Connector
AVERAGE LINEAR FORCE	197 kg (433 lbs)
STEP RESOLUTION	0.0794 µm/µstep
VOLTAGE RANGE	Universal input 100/240 VAC, 50/60 Hz
CABLE LENGTH	152 cm (5 ft) 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)

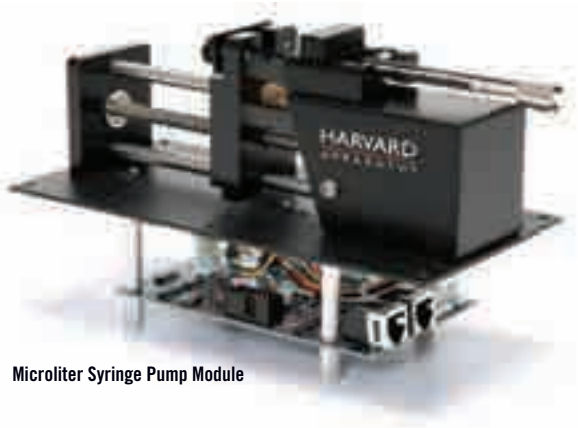
Order #	Product
PC2 70-2023	PHD 22/2000 Hpsi Programmable Syringe Pump
PC2 72-0199	Remote Extension Cable, 1.5 m (5 ft)
PC2 72-1405	Remote Extension Cable, 9.1 m (30 ft)
PC2 70-2022	RS-232 D-Sub 9-pin to RJ11-4 Connection Cable

PHD 4400 Hpsi Specifications	
TYPE	Microprocessor single syringe, infusion/withdrawal programmable
ACCURACY	±0.35%
REPRODUCIBILITY	±0.05%
SYRINGE:	
Type	Stainless steel**
Size Minimum	2.5 ml
Size Maximum	100 ml
FLOW RATE:	
Minimum	0.0076 µl/min
Maximum	182.40 ml/min
RS-232	RJ-11 4-conductor
TTL	9-pin D-Sub Connector
AVERAGE LINEAR FORCE	91 kg (>200 lbs)**
STEP RESOLUTION	0.082 µm/step
VOLTAGE RANGE	Universal input 100/240 VAC, 50/60 Hz
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

*** Plastic and glass syringes are not recommended because of high force.*

Order #	Product
PC2 70-2200	PHD 4400 Hpsi Programmable Single Syringe Pump
PC2 70-2201	PHD 4400 Hpsi Remote Programmable Single Syringe Pump

NEW Customized Solutions - OEM and Special Syringe Pumps



Microliter Syringe Pump Module

PHD ULTRA™ Syringe Pump Module

Harvard Apparatus offers a full line of OEM Pumps which can be integrated into an existing system or operate independently via computer control. Harvard Apparatus has a wealth of experience in the development and manufacture of specialized fluidic systems.

We offer the broadest selection of fluidics components, systems and specials. Whether your requirement is for a single order/one time study or you need a fluidic module to integrate into your system, we have the solution. With our extensive experience and variety of stand alone pumps and modules we can customize a product for your application. If you do not find what you are looking for, please contact our expert technical staff so we can review your specifications and work with you to develop or modify a product to meet your needs.

AMONG THE APPLICATION AREAS WHERE WE HAVE DEVELOPED OEM SOLUTIONS ARE:

- Mass Spectrometer Calibration Systems
- Medical Injection Devices
- Microfluidic Systems
- Drug Deposition Systems
- And More!

All of the Harvard Apparatus OEM modules are based upon our proven digital syringe pumps. They deliver the same accuracy and reproducibility as our stand alone pumps. We offer a wide range of flow rates and applied forces ranging from 6 lbs to 1,800 lbs.

Syringe diameter, flow rates and target volumes are stored in non-volatile memory. Serial communication is handled through either the RS-232 or USB ports depending upon the module. Every module is supplied with a serial cable. Some of the modules are available with or without a power supply while others come standard with a power supply.

Our manufacturing facilities in Massachusetts are registered with the U.S. Food and Drug Administration as manufacturer and contract manufacturing facilities.

OEM Syringe Pump Modules

	Order #	Flow Rate	Average Linear Force	Control	Communications
PUMP 11 ELITE MODULE	**PC2 70-4800**	1.28 pl/min to 88.28 ml/min	35 lbs at 100% Force Selection	PC or other external controller	USB input
MICROLITER SYRINGE PUMP MODULE	**PC2 70-2220 or PC2 70-2225**	0.001 µl/hr to 1.33 ml/min	6 lbs at 100% Force Selection	PC or other external controller	RS-232 serial input
MILLILITER SYRINGE PUMP MODULE	**PC2 70-2219 or PC2 70-2226**	0.001 ml/hr to 44.28 ml/min	25 lbs at 100% Force Selection	PC or other external controller	RS-232 serial input
HIGH PRESSURE SYRINGE PUMP MODULE	**PC2 70-2202**	0.0001 µl/hr to 220.82 ml/min	200 lbs at 100% Force Selection	PC or other external controller	RS-232 serial input
PHD ULTRA™ SYRINGE PUMP MODULE	**PC2 70-3506**	3.06 pl/min to 215.8 ml/min	75 lbs at 100% Force Selection	PC or other external controller	RS-232 and USB serial input
PHD ULTRA™ PUSH/PULL SYRINGE PUMP MODULE	**PC2 70-3508**	3.06 pl/min to 215.8 ml/min	75 lbs at 100% Force Selection	PC or other external controller	RS-232 and USB serial input
PHD ULTRA™ 4400 SYRINGE PUMP MODULE	**PC2 70-3510**	3.06 pl/min to 215.8 ml/min	200 lbs at 100% Force Selection	PC or other external controller	RS-232 and USB serial input

NEW Customized Solutions - OEM and Special Syringe Pumps (continued)

NEW Pump 11 Elite OEM Module

KEY FEATURES

- Accuracy of ±0.5%
- Footprint of 16.25 x 24.1 x 10.8 cm (6.5 x 9.5 x 4.25 in)
- 1.28 pl/min to 88.28 ml/min
- CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

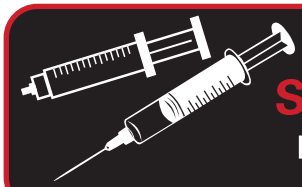
General Features and Capabilities

- All of our OEM modules are based upon our proven digital syringe pump technology delivering the same accuracy and reproducibility as our stand alone pumps.
- The modules consist of 3 basic components – a drive mechanism assembly, a motor assembly, and a circuit board assembly. In standard configurations, all are mounted to a base plate. These sub-assemblies can be purchased individually if required.
- All units have the ability to run in either direction (infuse/withdraw) at separate rates and target volumes.
- Although computer control is most commonly used for communication, a voltage level control for start/stop and change of direction is available. Our newer PHD ULTRA™ and Pump 11 Elite based modules can be rate controlled using an external DC 0-10 volt signal.
- All systems will accept input voltages over the range of 12-30 volts DC.
- Modification to accommodate existing designs or future designs is available.
- Modules can be linked together in a daisy chain fashion for complete computer control of up to 16 separate pumps at once. The PHD ULTRA™ based versions can control up to 99 pumps simultaneously.
- Our newest model, based upon our new PHD ULTRA™ syringe pump design, incorporates a stable mechanism, has an extended pushing block, larger guide rods, and easily adjustable capturing brackets and limit stops which fully protect the syringe and prevent siphoning. Models with either 75 or 200 pounds of adjustable force are available. These also offer a more enhanced I/O control and a USB serial port.
- We can configure our modules to support directional control valves, heating and cooling devices, custom syringes, and more.

Pump 11 Elite OEM Module Specifications	
TYPE	Microprocessor dual syringe, infusion/withdrawal
ACCURACY	±0.5%
REPRODUCIBILITY	±0.5%
SYRINGE TYPE	Plastic or glass
SYRINGE SIZE	
Minimum	0.5 µl
Maximum	60 ml (10 ml dual)
FLOW RATE:	
Minimum	1.28 pl/min
Maximum	88.28 ml/min
AVERAGE LINEAR FORCE	16 kg (35 lbs) at 100% force selection
CONNECTORS:	
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15-pin D-Sub Connector
OVERALL DIMENSIONS, H X W X D	16.25 x 24.1 x 10.8 cm (6.5 x 9.5 x 4.25 in)
WEIGHT	2.7 kg (6 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

Order #	Product
PC2 70-4800	Pump 11 Elite OEM Modules

** Please inquire for 2 syringe version.*



Syringe Options
Please see pages 50-59

NEW Customized Solutions - OEM and Special Syringe Pumps (continued)

OEM Modules: Microliter Syringe Pump Module

KEY FEATURES

- Accuracy of ±0.5%
- Footprint of 11.4 x 23.5 x 8.3 cm (4.5 x 9.25 x 3.25 in)
- 0.001 µl to 1.33 ml/min
- WEEE, EU RoHS

Microliter Syringe Pump Module Specifications	
TYPE	Microprocessor single syringe, infusion/withdrawal
ACCURACY	±0.5%
REPRODUCIBILITY	±0.1%
SYRINGE TYPE	Glass or plastic
SYRINGE SIZE:	
Size Minimum	0.5 µl
Size Maximum	1 ml
FLOW RATE:	
Minimum	0.001 µl/hr
Maximum	1.33 ml/min
AVERAGE LINEAR FORCE	2.73 kg (6 lbs) at 100% force selection
CONNECTORS:	
RS-232	4-pin RJ-11 telephone jack; dual RS-232 ports
DC Power	2-pin Header (friction lock)
POWER	+12 to +40VDC, 5%, 1A (12W) (User supplied)
DIMENSIONS:	
Overall, 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	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)

Order #	Product
PC2 70-2220	Microliter Syringe Pump Module without Power Supply
PC2 70-2225	Microliter Syringe Pump Module with Power Supply

OEM Modules: Milliliter Syringe Pump Module

KEY FEATURES

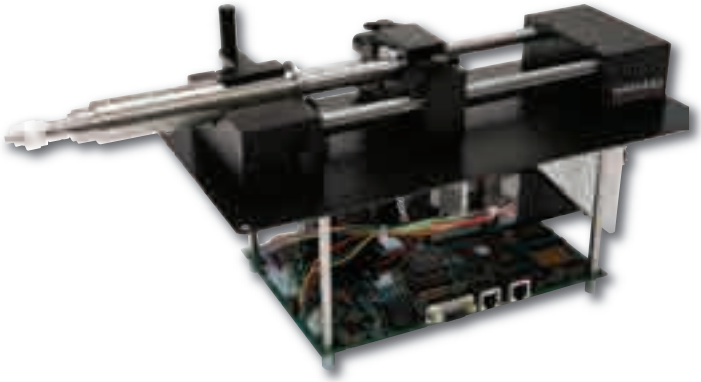
- Accuracy of ±0.5%
- Footprint of 13.5 x 24.1 x 10.8 cm (5.3 x 9.5 x 4.25 in)
- 0.001 µl/hr to 44.28 ml/min
- WEEE, EU RoHS

Milliliter Syringe Pump Module Specifications	
TYPE	Microprocessor single syringe, infusion/withdrawal
ACCURACY	±0.5%
REPRODUCIBILITY	±0.1%
SYRINGE TYPE	Glass or plastic
SYRINGE SIZE:	
Size Minimum	0.5 µl
Size Maximum	50/60 ml
FLOW RATE:	
Minimum	0.001 ml/hr
Maximum	44.283 ml/min
AVERAGE LINEAR FORCE	11.36 kg (25 lbs) at 100% force s+election
CONNECTORS:	
RS-232	4-pin RJ11 telephone jack; dual RS-232 ports
DC Power	2-pin Header (friction lock)
POWER	+12 to +40VDC (12W min) (user supplied)
DIMENSIONS:	
Overall, H x W x D	13.5 x 24.1 x 10.8 cm (5.3 x 9.5 x 4.25 in)
Mounting	22.9 x 9.5 cm (9.0 x 3.75 in), Mounting holes for (4) #8 Screws
WEIGHT	1.27 kg (2.8 lbs)

Order #	Product
PC2 70-2219	Milliliter Syringe Pump Module without Power Supply
PC2 70-2226	Milliliter Syringe Pump Module with Power Supply

NEW Customized Solutions - OEM and Special Syringe Pumps (continued)

OEM Modules: High Force Syringe Pump Module



KEY FEATURES

- Accuracy of ±0.5%
- Footprint of 16.8 x 14.0 x 30.2 cm (6.6 x 5.5 x 11.8 in)
- 0.001 µl/hr to 220.82 ml/min
- WEEE, Eu RoHS, ETL (UL, CSA)

High Pressure Syringe Pump Module Specifications	
TYPE	Microprocessor single syringe, infusion/withdrawal
ACCURACY	±0.5%
REPRODUCIBILITY	±0.1%
SYRINGE TYPE	Plastic, glass or stainless steel
SYRINGE SIZE:	
Size Minimum	0.5 µl
Size Maximum	140 ml
FLOW RATE:	
Minimum	0.001 µl/hr
Maximum	220.82 ml/min
AVERAGE LINEAR FORCE	90.91 kg (200 lbs)
CONNECTORS:	
DC Power	4-pin Header (Friction lock–Molex or AMP)
RS-232	4-pin RJ-11 Telephone Jack; dual RS-232 ports
User I/O	9-pin D-Sub Connector Female
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 12.7 cm (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) #8 screws
WEIGHT	3.86 kg (8.5 lbs)

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

Order #	Product
PC2 70-2202	High Pressure Syringe Pump Module without Power Supply

OEM Modules: PHD ULTRA™ Syringe Pump Module

KEY FEATURES

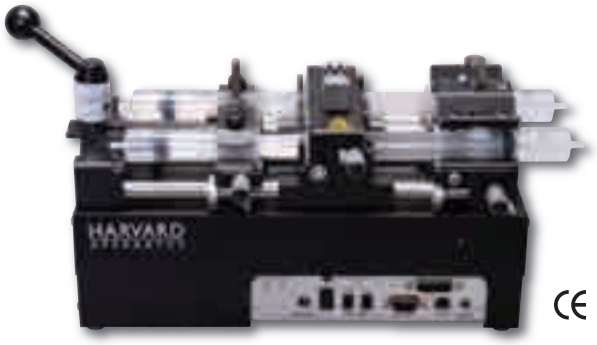
- Accuracy of ±0.25%
- Footprint of 29.8 x 14.0 x 16.5 cm (11.75 x 5.5 x 6.5 in)
- 3.06 pl/min to 215.8 ml/min
- CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

PHD ULTRA™ Syringe Pump Module Specifications	
TYPE	Microprocessor dual syringe, infusion/withdrawal
ACCURACY	±0.25%
REPRODUCIBILITY	±0.05%
SYRINGE TYPE	Plastic, glass or stainless steel
SYRINGE SIZE:	
Size Minimum	0.5 µl
Size Maximum	140 ml
FLOW RATE:	
Minimum	3.06 pl/min
Maximum	216.0 ml/min
AVERAGE LINEAR FORCE	34 kg (75 lbs) @ 100% Force Selection 30 VDC Input
CONNECTORS:	
RS-232	9-pin D-Sub Connector
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15-pin D-Sub Connector
DIMENSIONS	
Overall, H x W x D	29.8 x 14.0 x 16.5 cm (11.75 x 5.5 x 6.5 in)
WEIGHT	5.1 kg (11.2 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

Order #	Product
PC2 70-3506	PHD ULTRA™ Syringe Pump Module with Power Supply

NEW Customized Solutions - OEM and Special Syringe Pumps (continued)

OEM Modules: PHD ULTRA™ Push/Pull Syringe Pump Module



KEY FEATURES

- Accuracy of ±0.25%
- Footprint of 29.8 x 14 x 16.5 cm (11.75 x 5.5 x 6.5 in)
- 3.06 pl/min to 215.8 ml/min
- CE, ETL (UL, CSA), WEEE, EU RoHs and CB Scheme

PHD ULTRA™ Push/Pull Syringe Pump Module Specifications	
TYPE	Microprocessor four syringe, push/pull infusion/withdrawal
ACCURACY	±0.25%
REPRODUCIBILITY	±0.05%
SYRINGE TYPE	Plastic, glass or stainless steel
SYRINGE SIZE:	
Size Minimum	0.5 µl
Size Maximum	140 ml
FLOW RATE:	
Minimum	3.06 pl/min
Maximum	216.0 ml/min
AVERAGE LINEAR FORCE	34 kg (75 lbs) @ 100% Force Selection 30 VDC Input
CONNECTORS:	
RS-232	9-pin D-Sub Connector
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15-pin D-Sub Connector
DIMENSIONS	
Overall, H x W x D	29.8 x 14.0 x 16.5 cm (11.75 x 5.5 x 6.5 in)
WEIGHT	5.1 kg (11.2 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

Order #	Product
PC2 70-3508	PHD ULTRA™ Push/Pull Syringe Pump Module with Power Supply

OEM Modules: PHD ULTRA™ 4400 Syringe Pump Module

KEY FEATURES

- Accuracy of ±0.35%
- Footprint 29.8 x 14 x 16.5 cm (11.75 x 5.5 x 6.5 in)
- 3.06 pl/min to 215.8 ml/min
- CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

PHD ULTRA™ 4400 Syringe Pump Module Specifications	
TYPE	Microprocessor single syringe, infusion/withdrawal
ACCURACY	±0.35%
REPRODUCIBILITY	±0.05%
SYRINGE TYPE	Plastic, glass or stainless steel
SYRINGE SIZE:	
Size Minimum	0.5 µl
Size Maximum	140 ml
FLOW RATE:	
Minimum	3.06 pl/min
Maximum	216.0 ml/min
AVERAGE LINEAR FORCE	91 kg (200 lbs) @ 100% Force Selection
CONNECTORS:	
RS-232	9-pin D-Sub Connector
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15-pin D-Sub Connector
DIMENSIONS	
Overall, H x W x D	29.8 x 14.0 x 16.5 cm (11.75 x 5.5 x 6.5 in)
WEIGHT	5.3 kg (11.2 lbs)
REGULATORY CERTIFICATIONS	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

Order #	Product
PC2 70-3510	PHD ULTRA™ 4400 Syringe Pump Module with Power Supply

LabVIEW™ Driver

Take Control Of Your Syringe Pump

PROVIDES

- Virtual control from a PC of one or more syringe pumps
- Syringe pump control for many LabVIEW™ system applications

LabVIEW™ Drivers for Harvard Apparatus PHD 22/2000 Series, PHD ULTRA™ Series, Pump 22 and Pump 11 Plus are available. Built using the popular LabVIEW™ programming application from National Instruments.

LabVIEW™, the most widely used software for test, measurement, and control, delivers faster time to measurement with LabVIEW™. 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.

Using RS-232 communications and LabVIEW™ allows access to the following parameters:

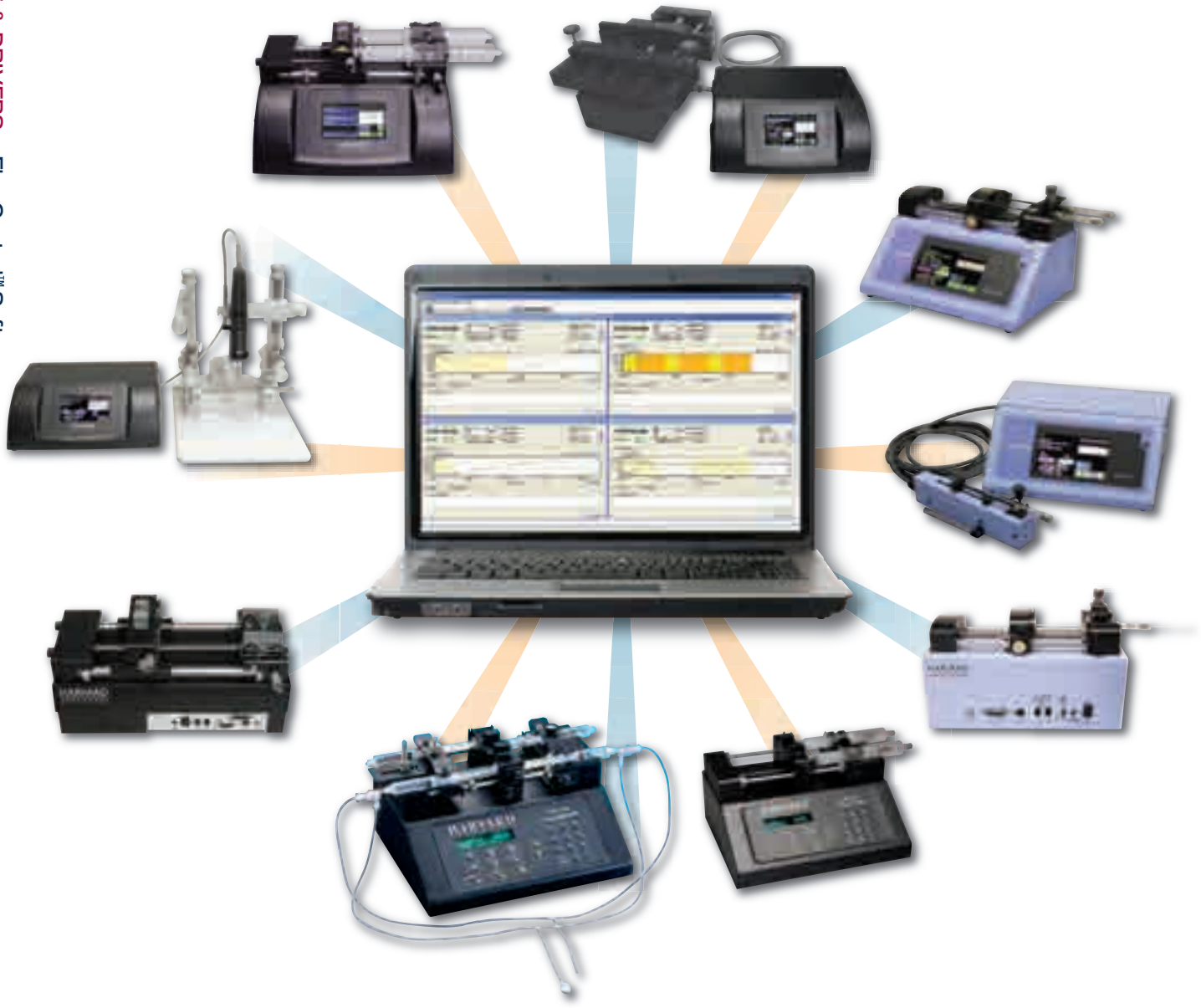
- **Set Auto-Fill Mode**
- **Set-Up Target Volumes**
- **Infuse Rate**
- **Refill Rate**
- **Diameter of Syringe**
- **On/Off Button**
- **Run/Stop**
- **Baud Rate**
- **Pump ID Number**
- **Direction of Flow**
- **Output for TTL**
- **Mode Selection**
- **System Status**
- **Software Version**
- **Command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

Please call technical support or e-mail techsupport@harvardapparatus.com to request your free copy.

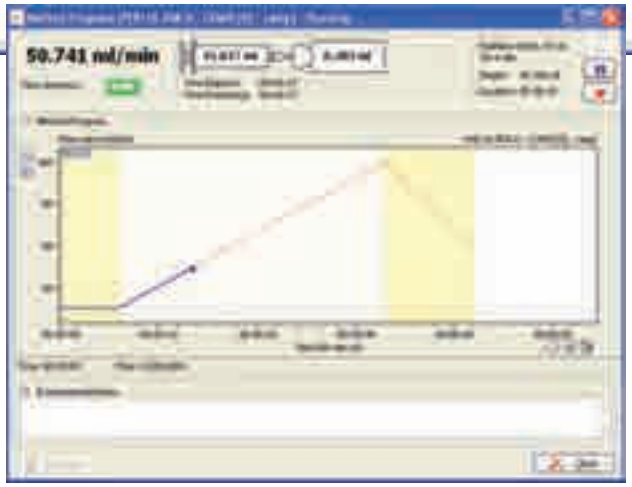
NEW FlowControl™ Software

FlowControl™
HARVARD APPARATUS SOFTWARE

Pump Control Software



NEW FlowControl™ Software (continued)



KEY FEATURES

- Single or multiple pump control
- Easily create simple Methods or more advanced multi-step Methods
- Run multiple pumps in a chain or via USB hub
- Displays all of the pump operating parameters
- Control the same or different pump models
- Graphically track pump progress
- Printable data log

FlowControl™ is an easy to use software program that is run on your PC. It is designed to work with key Harvard Apparatus Syringe Pumps that have an RS-232 or USB serial input including: PHD 22/2000 Series, PHD ULTRA™ Series and Pump 11 Elite Series of pumps.

Single or Multiple Pump Control

FlowControl™ has the ability to control single or multiple pumps. Multiple pumps are controlled in a daisy chain or via USB hub. The number of pumps allowed in a daisy chain is dependent upon the model.

Individual syringe pumps can be controlled by entering syringe data, flow rate and choosing a flow direction (infusion or withdrawal). Flow rate and flow direction can be changed while the pump is running.

FlowControl™ allows you to create, review, edit, save, recall and download Methods. You can create simple to complex Methods to control one or more pumps individually or simultaneously.

Pump Status

The pump configuration screen tells you the status of all defined pumps. If the light is green, the pump is ready. If the light is gray the pump is off line. If the light is red the software is detecting the wrong pump requiring you to check your connection.

Pump Graph

In addition to the run time execution information in the Method Execution window, FlowControl™ allows you to graphically monitor the real flow progress of each independent pump in the Method Progress window. The Method Progress screen displays all of the pumping parameters for the individual pump in an easy to read format. This allows you to monitor infuse and refill rates and volume dispensed.

Data Log

FlowControl™ creates a data log that tracks the activity of your pump based on a specific Method. When a data log is created three different files are generated with the same name but different extensions; excel report (*.xls), bitmap report (*.bmp) and experimental notes (*.txt). The bitmap report shows a screen shot of the pump flow evolution chart from the Method Progress window. Experimental Notes are notes typed in the Method Progress window by the user. The Excel report provides details about the Method parameters.

FlowControl™ Specifications	
COMPUTER REQUIREMENTS	1GHz Pentium® processor or higher, 512 MB of RAM (1 GB recommended)
SYSTEM REQUIREMENTS	Windows XP, 7, SP3 or Vista (Windows XP recommended)

Order #	Product
PC2 70-6000	FlowControl™ Software

Valves, Cables, Footswitches and Alarms

Continuous Delivery Valve Boxes

PC2 55-7007 Continuous Delivery Valve Box - High Pressure

PC2 55-7009 Continuous Delivery Valve Box- Normal Pressure

Continuous Delivery Valve Boxes are used with Pump 33 (PC2 55-3333) or PHD Push/Pull pumps only.

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) silastic tubing and a syringe pump connector cable. Maximum pressure is 25 p.s.i.

The Continuous Delivery Valve Box for high pressure has the valve assembly with lines for two syringe connections. Made of 304 stainless steel throughout it terminates in 6.4 mm (1/4 in) OD SWAGELOK® fittings and syringe pump connector cable. For the 30 and 200 p.s.i. models all wetted parts are stainless steel and perfluoroelastomer. For the 100 p.s.i. model all wetted parts are PTFE. Maximum pressure is 200 p.s.i. Specials are available.

Order #	Product
PC2 55-7009	Syringe Pump 33 Continuous Delivery Valve Box, Normal Pressure, 30 p.s.i.
PC2 55-7013	NEW Syringe Pump 33 Continuous Delivery Valve Box, Medium Pressure, 100 p.s.i.
PC2 55-7007	Syringe Pump 33 Continuous Delivery Valve Box, High Pressure, 200 p.s.i.

Foot Switch

PC2 55-4144

The PC2 55-4144 foot switch is for use with all Versions of the PHD 22/2000, see pages 32 and 33; all Versions of the Pump 4400 Hpsi, see page 35; Pump 33, see page 31; Pump 66/77, see page 65.

The PC2 55-2215 foot switch is for use with the Pump 22 only, see page 30. These start/stop foot switches which plug into the TTL connector provide hands-free control.

Order #	Product
PC2 55-4144	Foot Switch
PC2 55-2215	Foot Switch, Pump 22 ONLY

Pump 22 Reversing Switch

Allows pump to operate in either Infusion or Withdrawal modes. Requires Withdrawal Bracket which is not included. Call for details.

Order #	Product
PC2 55-2217	Pump 22 Reversing Switch

'Auto Fill' Valve Boxes

NEW PC2 55-7012 'Auto Fill' Valve Box- Medium Pressure

PC2 55-7008 'Auto Fill' Valve Box- High Pressure

The 'Auto Fill' Valve Boxes are for use with PHD 22/2000, PHD 4400 and PHD ULTRA™ Infusion/Withdrawal and Programmable Models only.

The 'Auto Fill' Valve Box for normal pressure has a one-sided pinch assembly. It is supplied with 3.2 mm ID x 6.4 mm (1/8 in x 1/4 in) OD silastic tubing and a 115/230 VAC, 50/60 Hz electrical connector with syringe pump connector cable. Maximum pressure is 50 p.s.i.

The 'Auto Fill' Valve Box for high pressure is made of 304 stainless steel throughout and terminates in 6.4 mm (1/4 in) OD SWAGELOK® fittings. For the 30 and 200 p.s.i. models all wetted parts are stainless steel and perfluoroelastomer, wetted parts can be changed for compatibility. Maximum pressure is 200 p.s.i. For the 100 p.s.i. models all wetted parts are PTFE. Specials are available.

Order #	Product
PC2 55-7010	'Auto Fill' Valve Box, Normal Pressure, 30 p.s.i.
PC2 55-7012	NEW 'Auto Fill' Valve Box, Medium Pressure, 100 p.s.i.
PC2 55-7008	'Auto Fill' Valve Box, High Pressure, 200 p.s.i.

RS-232 and RJ-11 Daisy Chain Cables

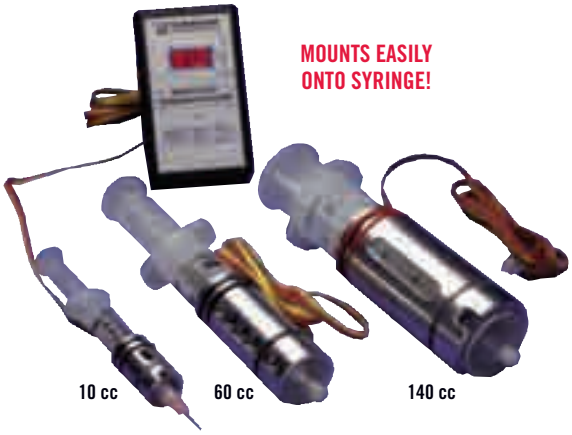
The PC2 70-2022 RS-232 Connection Cable is for use with all Harvard Apparatus Syringe Pumps except for the Pump 22 and the PHD ULTRA™. The PC2 55-4145 RS-232 Connection Cable is for use with the Pump 22. The PC2 70-4004 RS-232 Connection Cable is for use with the PHD ULTRA™ Syringe Pumps.

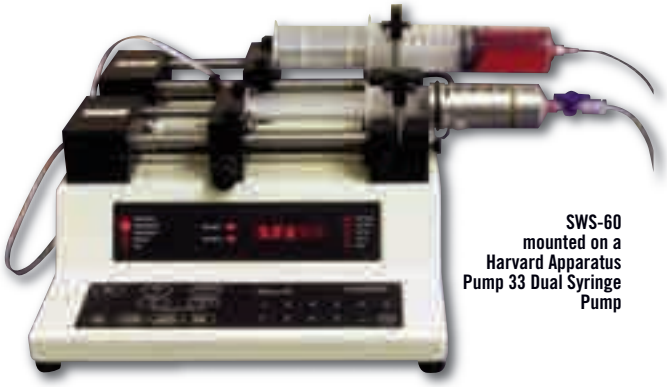
The PC2 55-7760 and PC2 72-2478 Daisy Chain Cables are for use with all Harvard Apparatus Syringe Pumps except for the Pump 22 and the PHD ULTRA™ without the legacy RS-232 (RJ-11 ports). The PC2 55-2239 Daisy Chain Cable is for use with Pump 22 only.

The PHD ULTRA™ daisy chain via RS-485 instead of RS-232. When controlling a syringe pump using a computer, a single RS-232 cable is required to connect the computer to the pump. If multiple pumps are being controlled by one computer then one Daisy Chain Cable is required for each additional pump.

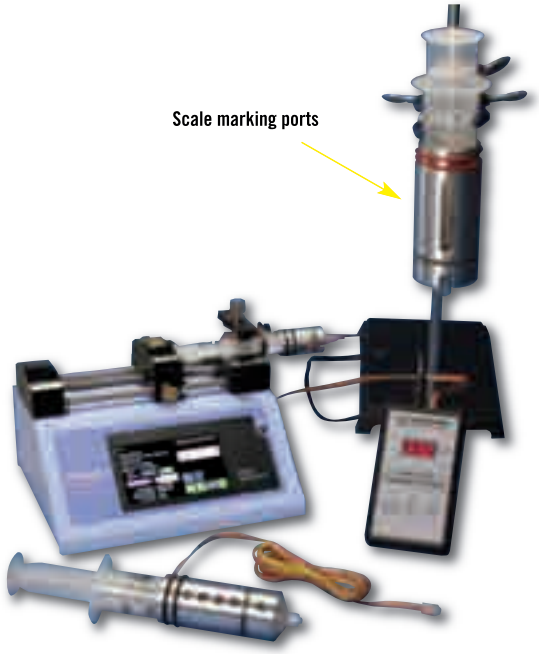
Order #	Product
PC2 70-2022	RS-232 Connection Cable, 7 ft, 9-pin D-Sub
PC2 70-4004	RS-232 Connection Cable, 6 ft, 9-pin D-Sub
PC2 55-4145	RS-232 Connection Cable, 7 ft, 25-pin D-Sub, Pump 22 ONLY. Do Not Use for Daisy Chaining
PC2 55-7760	Daisy Chain Cable, (2 ft) Need 1 Per Pump
PC2 72-2478	Daisy Chain Cable, (7 ft) Need 1 Per Pump
PC2 55-2239	Daisy Chain Cable and Adapter, (7 ft), Pump 22 ONLY Order 1 for Each Pump in the Chain

SWS-10, SWS-60 and SWS–140 Syringe Warmers





SWS-60 mounted on a Harvard Apparatus Pump 33 Dual Syringe Pump



KEY FEATURES

- Independent temperature control for individual syringes
- Designed for use on a syringe pump or support stand
- Syringe warmers work with 10 & 60 cc BD plastic syringes and 140 cc Monoject syringes
- Scale marking ports permit volume monitoring during use
- Can be powered from 12 volt battery for sensitive electrophysiology applications

The SWS-Series Syringe Warmers provide a simple and effective method for maintaining a stable temperature within a syringe. The compact design of this warmer allows it to be used either with a syringe pump or mounted on a support stand.

The thermally controlled heater housing slides onto a 10, 60, or 140cc syringe and is held in place with a self adjusting friction band. The housing incorporates a resistive element and thermistor, which when connected to a TC-124 temperature controller, allows the syringe warmer to be maintained at a constant temperature.

The heater housing is made of anodized aluminum which is both corrosion resistant and serves as an excellent thermal conductor. Solutions usually reach the set temperature approximately 15 minutes after application of power.

Be sure to order the TC-124 temperature controller with your syringe warmer.

Syringe Warmer Specifications	
HEATER RESISTANCE	18 Ω
VOLTAGE REQUIREMENT	Variable to 12 V maximum
TEMPERATURE RANGE	Ambient to 37°C
TEMPERATURE ACCURACY	±1°C
CABLE LENGTH	2.4 m (7.9 ft)
WARRANTY	One year

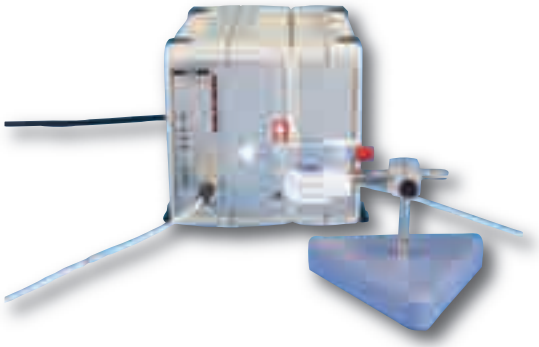
MODEL	WEIGHT	LENGTH	OD	ID	SYRINGE TYPE
SWS-10	32.7 g	38.2 mm	22.2 mm	16.2 mm	Becton Dickinson
SWS-60	76 g	83.7 mm	35.0 mm	29.1 mm	Becton Dickinson
SWS-140	192 g	109.5 mm	51.0 mm	41.4 mm	Monoject

Order #	Model	Product
PC2 64-1584	SWS-10	Syringe Heater for 10 cc Syringes
PC2 64-1560	SWS-60	Syringe Heater for 60 cc Syringes
PC2 64-1585	SWS-140	Syringe Heater for 140 cc Syringes
PC2 64-1545	TC-124A	Temperature Controller, 120 VAC US
PC2 64-1545E	TC-124AE	Temperature Controller, 240 VAC Europe
PC2 64-1655	TC-144	Temperature Controller
PC2 64-1606	BAC-1	Battery Adapter Cable

For full product offering on syringe warmers and temperature control, go to www.warneronline.com

Pressure Transducers for PHD ULTRA™ CP Syringe Pump

Transducer Amplifier Module (TAM-A and TAM-D)

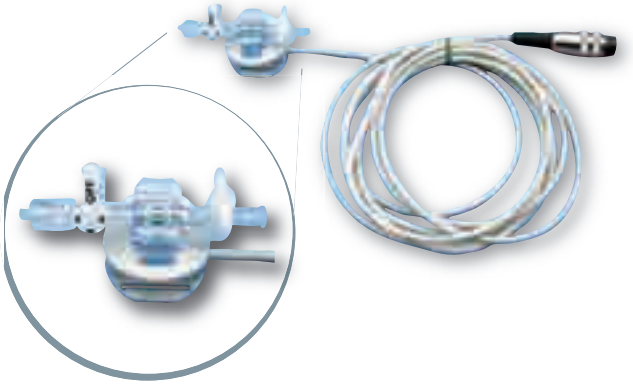


The Transducer Amplifier Module is a DC amplifier with bridge. It is used to amplify signals from transducers that are based on a resistive Wheatstone bridge. Transducers with a built-in preamplifier can also be connected. The TAM series amplifies the signal to a 0-10 V range making it ideal for use with the CP Pump series, which operates best with a full 0-10 V input range. As they are modular, a power supply case needs to be chosen. Cases are available that hold up to 2, 5, or 10 TAM modules. Choose from two: TAM-A (analog) and TAM-D (digital). The TAM-A is equipped with an analog LED bar graph signal indicator and is best suited for applications which require the monitoring of dynamic signals/phasic waveforms (e.g. blood pressure). The TAM-D has a digital numeric display and is best suited for applications with slowly changing signals, e.g. perfusion pressure, isometric or isotonic contractions, or intracranial pressures. For applications involving the CP Pump, the TAM-D is the appropriate choice. We have a range of transducers that interface directly with the TAM amplifiers.

Transducer Amplifier Module Specifications	
TRANSDUCER INPUT	6-pin socket with screw lock (binder, Amphenol Tuchel) Differential input circuit, input impedance $10^{10}\,\Omega$
GAIN	Selectable Ranges by Internal Jumper: 0.2 to 10, 0.4 to 20, 1 to 50, 2 to 100, 4 to 500, 20 to 1,000, 100 to 5,000, 200-10000. Fine Adjustment Through 10-Turn Trimmer
SIGNAL OUTPUT	a) On front panel through BNC socket ±10 V pulsatile filtered or mean signal output internally selectable b) Through bus connector to PLUGSYS measuring system through links ±10 V pulsatile filtered and mean signal voltage
OUTPUT LOW-PASS FILTER	a) Selectable by switch on front panel for pulsatile output signal: 30, 100, 300 Hz b) Selectable by internal jumper for mean output signal: 0.1, 0.3 Hz
ELECTRICAL CALIBRATION	Selectable by switch on front panel: a) 0 V output signal with switch in position '0' b) Positive or negative calibration output voltage adjustable with 10-turn trimmer if switch is in position 'CAL'
PLUGSYS WIDTH	2 slot units

Order #	Product
PC2 73-0065	Transducer Amplifier Module TAM-A
PC2 73-1793	Transducer Amplifier Module TAM-D
PC2 73-1523	PLUGSYS Minicase, Type 609

APT300 Blood Pressure Transducer



The APT300 transducer is an inexpensive pressure transducer which can be used to measure arterial blood pressures in all species, even on mice with a high heart rate.

It can be used for measurement of arterial pressure in vivo as well as for perfusion pressures in isolated perfused organs such as heart or kidney. It can also be used to measure isovolumetric left ventricular (using a balloon) pressures in isolated hearts from mice up to rabbits or pigs.

The transducer consists of a contact plate with cable and the exchangeable transducer head, which can easily be replaced. Contact plates with cables for different amplifier types are available.

APT300 Blood Pressure Transducer Specifications	
OPERATING PRESSURE	-300 to 300 mmHg
OVERPRESSURE	4,000 mmHg
SENSITIVITY	5 µV/V/mmHg (±1%)
TEMPERATURE COEFFICIENT	< 0.1% /°C
ZERO DRIFT	< 0.2 mmHg /°C
ZERO OFFSET	< 25 mmHg
EXCITATION VOLTAGE	2 – 15 V DC (or AC up to 5kHz)
ISOLATION AGAINST FLUID	> 5,000 V
OPERATING TEMPERATURE	15° to 40°C
STORAGE TEMPERATURE	-25° to 70°C
VOLUME DISPLACEMENT	< 0.04 mm^3/100 mmHg
OUTPUT IMPEDANCE	356 Ohm ±1%
FREQUENCY RESPONSE	> 1 KHz
CABLE LENGTH	3 m (9.8 ft)

Order #	Product
PC2 73-3862	APT300 Pressure Transducer for PLUGSYS TAM Amplifier
PC2 73-3869	Holder for APT300 Transducer, 8 mm Rod, Length 75 mm (3 in)
PC2 73-0500	Lab Stand with Triangular Base Plate with 30 cm (11.8 in) Rod
PC2 73-4140	Lab Stand with Triangluar Base Plate with 16 cm (6.3 in) Rod

Pressure Transducers for PHD ULTRA™ CP Syringe Pump (continued)

P75 Venous Pressure Transducer & P1500 Pressure Transducer

P75 Venous Pressure Transducer

The P75 has a removable Macrolon® dome with a pressure connection and a vent connection at the side, so that it can be filled free of air bubbles. The dome connections have a male Luer taper so that suitable stopcocks* can be attached. The transducer has a metal housing. The actual pressure sensor inside is made from ceramic and therefore has excellent resistance to different media. The transducer's rugged construction can withstand pressure overloads up to 4000 mmHg without damage. It works together with any DC bridge amplifier (e.g., PLUGSYS TAM-A).

P1500 Pressure Transducer

For applications requiring constant pressure control in the 0-30 PSI (0-2 bar) range, we offer the P1500 Pressure Transducer. Like the P75, it has a removable Macrolon® dome with a 90° pressure connection and 45° vent connection on the top side for filling the dome bubble free. The dome connections have a male Luer lock so that suitable stopcocks* can be attached. The transducer has a metal housing. The actual pressure sensor inside is made from ceramic and therefore has excellent resistance to different media. The transducer works with any DC bridge amplifier (e.g. PLUGSYS TAM-A) but is supplied with the connector for the TAM. Configurations for other amplifiers available upon request.

**Use one each of PC2 73-0096 three-way stopcock and PC2 73-0097 one-way stopcock*

Order #	Product
PC2 73-0020	Blood Pressure Transducer P75 for PLUGSYS TAM Amplifier
PC2 73-3806	Blood Pressure Transducer P1500 for PLUGSYS TAM Amplifier

Millar Pressure Catheters

2F Pressure Catheter SPR-407

Millar pressure catheters continue to represent the gold standard for high-fidelity pressure measurements for both systematic and intraventricular applications.

Adapters and cables are available to connect catheters directly to the range of Harvard Apparatus pressure amplifiers.

Order #	Model	Product
Adapters and Cables		
PC2 72-9842	HEC-10C	Pressure Catheter with **Viking Connector** to PLUGSYS TAM Amplifier
PC2 72-9843	HEC-10D	Pressure Catheter with **Low Profile Connector** to PLUGSYS TAM Amplifier
Millar Pressure Catheters		
PC2 72-9781	SPR-1000	1F, Single pressure, 20 cm, Straight, Non-repairable **(Low Profile)**
PC2 72-9779	SPR-671	1.4F Single pressure,1.1F-2F body 15 cm from tip, 65 cm **(Low Profile)**
PC2 72-9775	SPR-407	2F Sensor, 1.5F Body, Single Pressure, 140 cm, Straight **(Viking)**
PC2 72-9777	SPR-524	3.5F Single pressure, 100 cm, Straight, Non-repairable **(Viking)**

P75 and P1500 Pressure Transducers Specifications

Model	P75 Pressure Transducer	P1500 Pressure Transducer
PRESSURE RANGE	±75 mmHg (±100 cmH_2O)	±1,500 mmHg (±30 PSI)
OVERLOAD	-760 (=vacuum) to 4,000 mmHg	13,500 mmHg
SENSITIVITY	1 mV/mmHg, nominal	0.05 mV/mmHg, nominal
TEMPERATURE RANGE	0° to 50°C	-20° to 80°C
ZERO DRIFT	±0.04 mmHg/10°C (0° to 50°C)	±0.5% FS (-20° to 80°C)
RANGE DRIFT	±0.04 mV/10°C (±0.04 mmHg/10°C) (0° to 50°C)	±0.5% FS (-20° to 80°C)
LONG-TERM DRIFT	±0.04 mmHg FS/Year	±0.1% FS/Year
VOLUME DISPLACEMENT	0.06 mm^3/10 mmHg	0.004 mm^3/10 mmHg
FREQUENCY RANGE	0 to 100 Hz	0 to 300 Hz
OUTPUT RESISTANCE	300 Ω, nominal	
EXCITATION VOLTAGE	5 V (4.5 to 5.5 V) DC only	
PRESSURE CONNECTIONS	Male Luer Lock	
CONNECTION CABLE	1.5 m (4.9 ft) long	
MOUNTING ROD, OD x L	8 x 70 mm (0.31 x 2.76 in)	

Pressure Transducers for PHD ULTRA™ CP Syringe Pump (continued)

Samba Sensor

The Samba transducer is an appropriate choice for use with the PHD ULTRA™ CP pump when a lower flow rate (1/2 the total range of the pump) is sufficient to reach the desired end pressure as this system as a maximum 5 V output. Because the system has an ultra-miniature sensor profile (360 µm/420 µm tip dimension) and a bare fiber shaft of 250 µm diameter, it is particularly suited for placement in small spatial areas that require a minimal mass displacement. The primary benefits of the Samba Preclin Transducer are the ability to measure the pressure at the source, with no dampening due to a fluid filled conduction line, and its extremely high frequency response (40 kHz), which allows it to capture transient pressure changes.

The Samba Preclin is a fiber optic transducer which is insensitive to electro-magnetic fields and therefore is optimal for use in an MRI environment. Options for radio-opaque coating are also available. The ability to use the transducer in multiple imaging modalities allows for a constant pressure infusion of dyes or other substances in real time during the imaging process.

Samba 201/202

The new Samba control unit is a compact, portable and battery operated unit equipped with internal memory for temporary data storage. The Samba 201 has one fiber optic port while the Samba 202 is fitted with two ports, which allow for extended operations. The individual calibration data stored on the EPROM of each connected Samba transducer is automatically read by the control units to ensure exact measurements. The USB 2.0 date interface simplifies the data transmission to your computer and the 3.2 inch display performs sharp figures.

Samba 201/202 Specifications	
FIBER OPTIC PORTS	1 (Samba 201), or 2 (Samba 202)
RESOLUTION	0.018 mbar (~1.8 Pa; Samba Preclin 420 transducer)
NUMERICAL RESOLUTION	15 bit
DATA RATE	1 to 40,000 Hz
MEASUREMENT	Absolute or Relative (/Diff.; Samba 202)
OUTPUTS	USB 2.0, Analog out
ANALOG OUTPUT	0-5 V
BATTERY OPERATION	Up to 8 Hz (2 channels at 40 kHz)
OPERATING TEMPERATURE	15° to 35°C (59° to 95°F)
DISPLAY	81 mm (3.2 in) monochrome
DIMENSIONS	210 x 110 x 45 mm (8.5 x 4.3 x 1.8 in)
WEIGHT	950 g (2.1 lbs)

Samba Preclin

The Samba Preclin pressure transducer comprises a silicon sensor element mounted on an optical fiber. Each transducer is calibrated at the factory before delivery to eliminate the need for customer calibration. The calibration data is stored on a small EPROM positioned on the connector and is read automatically at start up.

Samba Preclin Specifications	
SENSOR DIAMETER	0.36 mm (1.1 F; high pressure) 0.42 mm (1.3 F; low pressure)
FIBER DIAMETER	0.25 mm (0.75 F), incl. standard coating 0.40 mm (1.2 F), incl. radiopaque coating
CALIBRATION	Factory calibration (on-site calibration not needed)
MEASUREMENT MEDIA	Fluid or gas
TOLERATED BEND RADIUS	10 mm (0.4 in)
AVAILABLE PRESSURE RANGES:	
Low Pressure	-50 to 350 mbar (-37.5 to 262.5 mmHg)
High Pressure I	-0.1 to 5 bar
High Pressure II	-0.1 to 10 bar
High Pressure III	-0.1 to 17 bar
ACCURACY -50 TO 350 MBAR	±0.5 mbar and ±2.5% of reading (-50 to 250 mbar) or ±4% of reading (250 to 350 mbar)
ACCURACY -0.1 TO 5 BAR	±10 mbar and ±2.5% of reading (-0.1 to 3 bar) or ±10 mbar and ±3% of reading (3 to 5 bar)
ACCURACY -0.1 TO 10 BAR	±15 mbar and ±2.5% of reading (-0.1 to 6 bar) or ±15 mbar and ±3% of reading (6 to 10 mbar)
ACCURACY -0.1 TO 17 BAR	±20 mbar and ±2.5% of reading (-0.1 to 10 bar) or ±20 mbar and ±3% of reading (10 to 17 bar)
TEMPERATURE COEFFICIENT -50 TO 350 MBAR	< 0.2 mbar/°C (20° to 45°C/ 68° to 113°F)
TEMPERATURE COEFFICIENT -0.1 TO 5 BAR	< 3.5 mbar/°C (20° to 45°C/ 68° to 113°F)
TEMPERATURE COEFFICIENT -0.1 TO 10 BAR	< 7 mbar/°C (20° to 45°C/ 68° to 113°F)
TEMPERATURE COEFFICIENT -0.1 TO 17 BAR	< 14 mbar/°C (20° to 45°C/ 68° to 113°F)
LONG TERM STABILITY	< 0.5% of range
STORAGE TEMPERATURE	-40° to 80°C (-40° to 176°F)
TOTAL TRANSDUCER LENGTH	4 m (13.1 ft), or 10 m (32.8 ft) for MRI use
STANDARD BARE FIBER LENGTH	5 cm (2 in), or 15 cm (6 in)
STANDARD LENGTH OF LOOSE PTFE TUBING	10 cm (4 in)
COATING	Standard, or Radiopaque (visible under X-ray)

* For order information, please see page 49.

Pressure Transducers for PHD ULTRA™ CP Syringe Pump (continued)

Samba Sensor (continued)

Order #	Product
50-433101	Samba 201 Control Unit with One Fiber Optic Channel Plus Software
50-433102	Samba 202 Control Unit with Duel Fiber Optic Channel Plus Software

*The dual channel unit cannot accommodate more than one 10-meter MRI-compatible transducer. It is suitable for use with any of the following combinations: 1 x 4-meter transducer, 2 x 4-meter transducers, 1 x 10-meter & 1 x 4-meter transducer, or 1 x 10-meter transducer.

Transducers

Order #	Product	Total Length	Bare Fiber	Pressure Range
PC2 50-461121	Samba 420LP Fiber Optic Pressure Transducer Only	400 cm (157. 5 in)	15 cm (5.9 in)	-50 to +350 mbar
PC2 50-461123	Samba 420LP Fiber Optic Pressure Transducer Only Radio-Opaque Coating	400 cm (157.5 in)	15 cm (5.9 in)	-50 to +350 mbar
PC2 50-461125	Samba 420LP Fiber Optic Pressure Transducer Only, MRI Version	1,000 cm (393.7 in)	15 cm (5.9 in)	-50 to +350 mbar
PC2 50-461141	Samba 360 HPI Fiber Optic Pressure Transducer Only	400 cm (157.5 in)	15 cm (5.9 in)	-0.1 to +5 bar
PC2 50-461161	Samba 360 HPII Fiber Optic Pressure Transducer Only	400 cm (157.5 in)	15 cm (5.9 in)	-0.1 to +10 bar
PC2 50-461181	Samba 360 HPIII Fiber Optic Pressure Transducer Only	400 cm (157.5 in)	15 cm (5.9 in)	-0.1 to +17 bar

** Additional sensor options available, please contact technical support.*

Research Grade Blood Pressure Transducer

KEY FEATURES:

- An extremely versatile and accurate pressure transducer
- Simple to use and robust
- Transducer and Amplifier in a single compact unit
- BNC output for connection to virtually any data acquisition system

Because the maximum voltage output of the built-in amplifier is 3V, the RGBP transducer is only suitable for use with the CP Pump series if the expected flow rate range for the selected syringe size falls within the bottom 30% of the pusher block speed of the pump. Using a larger syringe size allows a higher flow rate in the lower 30% and may be necessary if larger flows are required to reach the desired pressure setpoint.

The RGBP uses a unique electronic circuit (US Patent #4,142,144) which is extremely sensitive and stable, producing a signal suitable for direct connection to records, oscillographs, computers, and the CP Pump series. The transducer has a 3-digit backlit display, measures signals in the physiological range of -50 to 300 mmHg, and is small enough to fit in any lab space.

The Transducer uses a semi-disposable dome of medical grade Silastic® with an integral silicone rubber diaphragm which are supplied sterile and can be re-sterilized with no effects on performance. The transducer has a built-in rod designed to be mounted on a clamp and stand (such as PC2 73-0500 Triangular Stand with Clamp), and is not supplied with stopcocks (sold separately)*.

Please note that replacement domes listed on this page are for Harvard Apparatus' newer model transducer only which is distinguished by the white ring at the base of the dome. Replacement domes for older units are not available.

**Use one each of PC2 73-0096 three-way stopcock and PC2 73-0097 one-way stopcock*

Research Grade Blood Pressure Transducer Specifications	
OUTPUT VOLTAGE	Factory set at 1.0 V/100 mmHg via BNC connector; calibrated up to 200 mmHg
LINEARITY	±1.5% of full scale
COMPLIANCE	14 µl displacement /100 mmHg, including 305 mm (12 in) of standard 3 mm (1/8 in) ID vinyl tubing
DOME VOLUME	300 µl
PRESSURE RANGE	-50 to +300 mmHg
OVERLOAD PRESSURE	3000 mmHg
ZERO OFFSET CONTROL	-50 to +100 mmHg
NATURAL FREQUENCY	> 500 Hz, dry
ELECTRICAL ISOLATION	> 1 kV
CARRIER FREQUENCY	2 MHz
OUTPUT IMPEDANCE	2 kΩ
INPUT LIQUID CONNECTOR	Dual transparent male Luer Lock
DRIFT	Negligible after 5 min. warm-up
STERILIZATION OF TRANSDUCER	Chemical: Alcide, Cidex, etc.
DIMENSIONS:	
Transducer, H x W x D	43 x 30 x 55 mm (1-1/2 x 1-1/8 x 2-1/4 in)
Handle, OD x L	9.7 x 76.2 mm (3/8 x 3 in)
Amplifier, H x W x D	51 x 95 x 886 mm (2 x 3-3/4 x 3-3/8 in)
DISPLAY	LCD, 7.6 mm (0.3 in) high numbers
WEIGHT	908 g (2 lbs)

Order #	Product
PC2 72-4496	Research Blood Pressure Transducer, 115 VAC, 60 Hz
PC2 72-4497	Research Blood Pressure Transducer, 230 VAC, 50 Hz
PC2 72-4498	Replacement Dome, pkg. of 1 (Older units require retrofit)

Harvard Apparatus Stainless Steel Syringes

KEY FEATURES

- 7500 psi peak pressure (with 2.5 ml syringes)
- Fits most Harvard Apparatus pumps
- Electron beam welded
- Fully autoclavable
- 1/16 inch SWAGELOK® fitting for low dead volume

High Pressure Stainless Steel Syringes

Harvard Apparatus offers a complete 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 2.5, 8, 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.

High Pressure 2.5 ml and 8 ml Stainless Steel Syringes

These syringes have been designed to utilize the high forces available in our syringe pumps to produce pressures up to 7,500 psi and 1,500 psi respectively. These syringes are constructed entirely of #316 stainless steel. The 2.5 ml stainless steel syringe contains one Perfluoroelastomer O-Ring seal and one Ball seal. This syringe is available with a 1/16 inch SWAGELOK® tip only. The 8 ml stainless steel syringe contains two Perfluoroelastomer O-Ring seals and two PTFE O-Ring seals. This syringe is available with a 1/16 inch or 1/8 inch SWAGELOK® tip.

High Pressure 20 ml to 200 ml Stainless Steel Syringes

Both syringe barrel end plungers are #316 stainless steel. A Viton O-Ring between top and end of the barrel insures against leakage. Syringes are guaranteed to be leak free for pressures up to 750 psi.

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

For illustration and syringe dimensions, see next page.

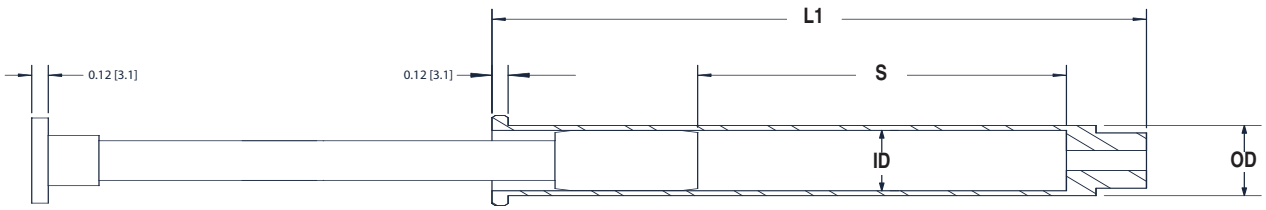
Order #	Product
Replacement Parts	
PC2 5013-087	Perfluoroelastomer Barrel O-Ring 8 ml
PC2 5013-089	Perfluoroelastomer Barrel O-Ring 20 ml
PC2 5013-090	Perfluoroelastomer Barrel O-Ring 50 ml
PC2 5013-091	Perfluoroelastomer Barrel O-Ring 100 ml
PC2 5013-092	Perfluoroelastomer Barrel O-Ring 200 ml
PC2 5013-110*	Perfluoroelastomer Tip Seal O-Ring 2.5 ml and 8 ml
PC2 5013-109	Perfluoroelastomer Tip Seal O-Ring 20 ml to 200 ml
PC2 72-2472	Replacement Viton O-Ring 20 ml, pkg. of 10
PC2 72-2473	Replacement Viton O-Ring 50 ml, pkg. of 10
PC2 72-2474	Replacement Viton O-Ring 100 ml, pkg. of 10
PC2 72-2475	Replacement Viton O-Ring 200 ml, pkg. of 10
PC2 72-2616	Replacement Viton Tip Seal O-Ring, 20 ml to 200 ml, pkg. of 20
PC2 70-2271	Replacement Ball Seal for 2.5 ml
PC2 5013-088	Replacement Backup PTFE O-Ring, 8 ml
PC2 72-2617	Stainless Steel Plunger Button to Adapt Syringe for Use with PHD 22/2000 Hpsi, see page 35 (Required for 50 and 100 ml Syringes Only)

**Note: 2.5 ml and 8 ml stainless steel syringes cannot be used with PHD 22/2000 Hpsi Pumps (PC2 70-2023 or PHD ULTRA Hpsi) due to overpressure conditions.*

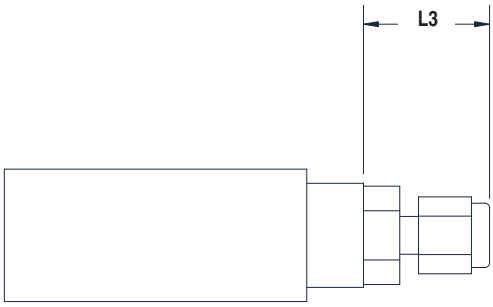
High Pressure Stainless Steel Syringes

	With SWAGELOK®			With Luer Lock
SYRINGE SIZE	**DIAMETER 1/16 INCH**	**DIAMETER 1/8 INCH**	**DIAMETER 1/4 INCH**	
2.5 ml	**PC2 70-2269**	**N/A**	**N/A**	**N/A**
8 ml	**PC2 70-2267**	**PC2 70-2268**	**N/A**	**N/A**
20 ml	**PC2 70-2251**	**PC2 70-2252**	**PC2 70-2253**	**PC2 70-2254**
50 ml	**PC2 70-2255**	**PC2 70-2256**	**PC2 70-2257**	**PC2 70-2258**
100 ml	**PC2 70-2259**	**PC2 70-2260**	**PC2 70-2261**	**PC2 70-2262**
200 ml	**PC2 70-2263**	**PC2 70-2264**	**PC2 70-2265**	**PC2 70-2266**
Replacement Tips, Furnished with Sealing O-Ring				
2.5 ml	**PC2 70-2246**	**N/A**	**N/A**	**N/A**
8 ml	**PC2 70-2246**	**PC2 70-2245**	**N/A**	**N/A**
20 ml to 200 ml	**PC2 70-2247**	**PC2 70-2248**	**PC2 70-2249**	**PC2 70-2250**

Harvard Apparatus Stainless Steel Syringes (continued)



SYRINGE (ML)	FITTING	L3 (IN)	(MM)
2.5 to 8	1/16	0.74	(18.8)
2.5 to 8	1/8	0.91	(23.1)
20 to 200	1/16	0.67	(17.0)
20 to 200	1/8	0.84	(21.3)
20 to 200	1/4	0.94	(23.9)
20 to 200	Luer	1.34	(34.0)



Harvard Apparatus Stainless Steel Syringes Specifications

VOLUME	2.5 ml		8 ml		20 ml		50 ml		100 ml		200 ml	
MAXIMUM TEST PRESSURE	9,000 psi		4,000 psi		1,500 psi		1,500 psi		1,500 psi		1,500 psi	
WORKING PRESSURE	7,000 psi		1,500 psi		750 psi		750 psi		750 psi		750 psi	
DIMENSIONS	in	(mm)	in	(mm)	in	(mm)	in	(mm)	in	(mm)	in	(mm)
OVERALL LENGTH OF BARREL - (L1)	6.625	(168.3)	6.73	(170.8)	4.73	(120.1)	5.49	(139.3)	6.73	(170.9)	81.48	(215.4)
PLUNGER EXCURSION - (S)	4.75	(120.6)	4.42	(112.4)	3.56	(90.3)	4.14	(105.2)	5.67	(143.9)	7.20	(182.8)
OUTSIDE DIAMETER - (OD)	0.50	(12.7)	0.50	(12.7)	0.88	(22.2)	1.25	(31.8)	1.50	(38.1)	1.88	(47.63)
INSIDE DIAMETER - (ID)	0.187	(4.75)	0.375	(9.525)	0.753	(19.13)	1.126	(28.60)	1.374	(34.90)	1.762	(44.75)

Hamilton™ Glass Syringes

Harvard Apparatus 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 technical support department for the latest offerings.

KEY FEATURES

- Sizes from 0.5 µl to 100 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

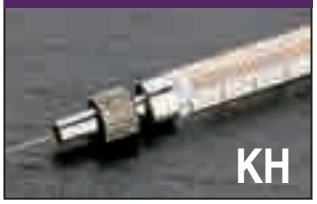
Syringes end in one of the following configurations:

LT - Luer Tip, standard tapered male Luer

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

C - Chem fitting, 0.375 in long 1/4-28 UNF Male

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



TLL - PTFE 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

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 the microliter syringes including syringe guides for added plunger stability and cleaning wires and solution to maximize the life of your syringe.

All Hamilton™ glass syringes are autoclavable when disassembled except for syringes with cemented needles.

Syringe Plungers

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

Standard Plunger

Instrument Plunger
CX - Chem with stop
TLLX - PTFE 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. Only available for 1700 series GASTIGHT® syringes.

Special Needle Sizes

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

Special Needle Sizes (mm)

GAUGE THICKNESS	OD	ID	WALL
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 122 for needle size chart. Custom needle tips, gauges and lengths are available, call for more information.

Hamilton™ Glass 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 55 and 56).
- **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 55 and 56).
- **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, please visit our website.
- **Chem Terminus** – Select syringes with a C terminus if you require a threaded fitting for high pressure applications.

NEW Hamilton™ Neuros™ Syringes.

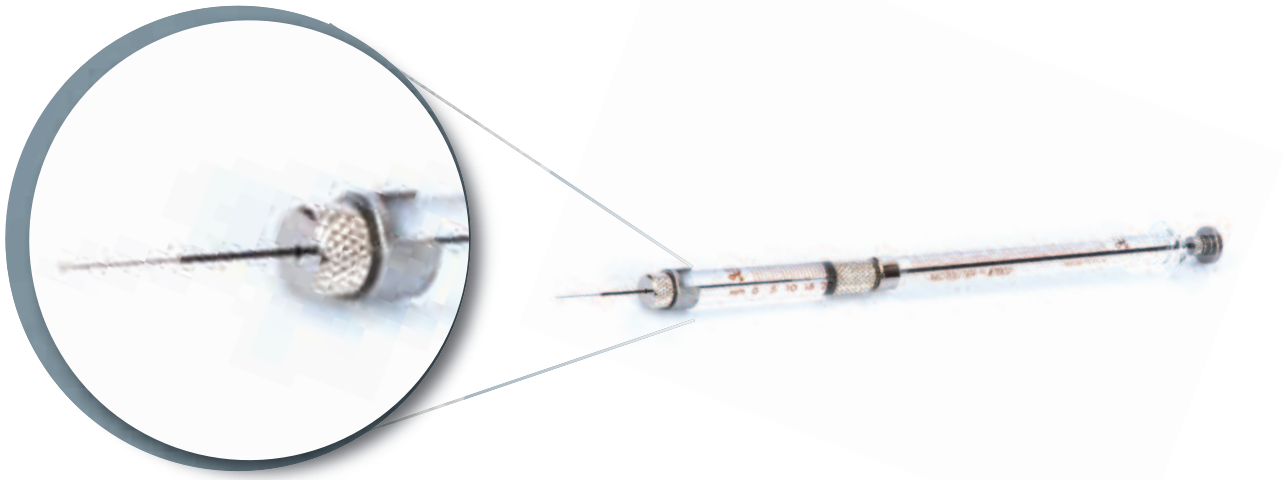
- **Accurately dispenses 50 nl to 100 µl of liquid to an exact location**
- **Maintains rigidity and creates the smallest injection site possible**
- **Little to no dead volume which eliminates sample loss and saves money**

See next page for full product details.

Syringe Graduations								
100 LINE SCREENS								
7000 SERIES MODIFIED MICROLITER SYRINGES	**0.5 µl**	**1 µl**	**2 µl**	**5 µl**				
Scale Length, cm	6	6	6	6				
Total Scale Divisions	100	100	100	100				
Major Graduations, µl	0.05	0.1	0.2	0.5				
Minor Graduations, µl	0.01	0.02	0.04	0.1				
Sub-Minor Graduations, µl	0.005	0.01	0.02	0.05				
700 & 800 SERIES MICROLITER SYRINGES	**5 µl**	**10 µl**	**25 µl**	**50 µl**	**100 µl**	**250 µl**	**500 µl**	
	75, 85	**701, 801**	**702, 802**	**705, 805**	**710, 810**	**725, 825**	**750**	
Scale Length, cm	5.41	5.41	6	6	6	6	6	
Total Scale Divisions	100	100	100	100	100	100	100	
Major Graduations, µl	0.5	1	2.5	5	10	25	50	
Minor Graduations, µl	0.1	0.2	0.5	1	2	5	10	
Sub-Minor Graduations, µl	0.05	0.1	0.25	0.5	1	2.5	5	
1700 & 1800 SERIES GASTIGHT SYRINGES	**10 µl**	**25 µl**	**50 µl**	**100 µl**	**250 µl**	**500 µl**		
	1701, 1801	**1702, 1802**	**1705, 1805**	**1710, 1810**	**1725, 1825**	**1750**		
Scale Length, cm	6	6	6	6	6	6		
Total Scale Divisions	100	100	100	100	100	100		
Major Graduations, µl	1	2.5	5	10	25	50		
Minor Graduations, µl	0.2	0.5	1	2	5	10		
Sub-Minor Graduations, µl	0.1	0.25	0.5	1	2.5	5		
1000 SERIES GASTIGHT SYRINGES	**1 ml**	**1.25 ml**	**2.5 ml**	**5 ml**	**10 ml**	**25 ml**	**50 ml**	**100 ml**
	1001	**1001.25**	**1002**	**1005**	**1010**	**1025**	**1050**	**1100**
Scale Length, cm	6	6	6	6	6	6	6	12
Total Scale Divisions	100	100	100	100	100	100	100	200
Major Graduations, ml	0.1	0.125	0.25	0.5	1	2.5	5	5
Minor Graduations, ml	0.02	0.025	0.05	0.1	0.2	0.5	1	1
Sub-minor Graduations, ml	0.01	0.0125	0.025	0.05	0.1	0.25	0.5	0.5
SUPER SYRINGES	**500 ml**	**1000 ml**	**1500 ml**	**2000 ml**				
	S0500	**S1000**	**S1500**	**S2000**				
Scale Length, inches	6.53	6.57	9.85	13.13				
Total Scale Divisions	25	50	75	100				
Major graduations, ml	100	100	100	100				
Minor graduations, ml	20	20	20	20				

Hamilton™ Glass Syringes (continued)

NEW Neuros™ Syringes



KEY FEATURES

- Accurately dispenses 50 nl to 100 µl of liquid to an exact location
- Maintains rigidity and creates the smallest injection site possible
- Little to no dead volume which eliminates sample loss and saves money
- Two sleeve options – one with a blind stop for cannulated animals and another without for stereotaxic holders
- Adjustable needle exposure of 0 to 20 mm gives you full control
- Compatibility with most stereotaxic holders and infusion pumps means an easy integration into your process

Hamilton Neuros™ syringe technology provides unprecedented functionality for controlled animal injections. The Neuros accurately dispenses volumes between 50 nl to 100 µl through an ultrafine needle with a blunt point (point style 3).

Developed specifically for neuroscience applications, the Neuros syringe enables the delivery of microvolumes to an exact location while minimizing injection site damage. Neuros syringes come with two types of protective needle sleeves. The sleeve with a blind stop is perfect for cannulated applications and ensures targeted administration with an adjustable penetration depth. The version without a blind stop works best with stereotaxic holders. Both types provide an adjustable needle exposure of 0 to 20 mm.

These new Neuros™ Syringes are compatible with Harvard Apparatus syringe pumps.

Order #	Product
PC2 75-0015	0.5 µl Neuros 7000 Series KH Syringe
PC2 75-0016	1.0 µl Neuros 7000 Series KH Syringe
PC2 75-0017	2.0 µl Neuros 7000 Series KH Syringe
PC2 75-0018	5 µl 700 Series RN Syringe and Neuros Adapter Kit
PC2 75-0019	10 µl 1700 Series RN Syringe and Neuros Adapter Kit
PC2 75-0020	25 µl 1700 Series RN Syringe and Neuros Adapter Kit
PC2 75-0021	50 µl 1700 Series RN Syringe and Neuros Adapter Kit
PC2 75-0022	100 µl 1700 Series RN Syringe and Neuros Adapter Kit
PC2 75-0023	Neuros Adapter Kit for 100 µl RN Syringe and smaller
PC2 75-0024	Neuros Replacement Needle, 33 gauge, Small Hub RN Needle, 3.03 in, point style 3, 6/pk

Hamilton™ Glass Syringes (continued)

800 Series Syringes

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

800 Series Syringes

					Replacement Parts	
ORDER #	Vol.	Ter.	Point Style	Ga.*	Needle (pkg. of 6)	Plunger Barrel Assembly
PC2 72-1724	5 µl	RN	2	26s	PC2 72-5744	PC2 72-1730
PC2 72-1725	10 µl	RN	2	26s	PC2 72-5744	PC2 72-1731
PC2 72-1726	25 µl	RN	2	22s	PC2 72-5745	PC2 72-1732
PC2 72-1727	50 µl	RN	2	22s	PC2 72-5745	PC2 72-1733
PC2 72-1728	100 µl	RN	2	22s	PC2 72-5745	PC2 72-1734
PC2 72-1729	250 µl	RN	2	22s	PC2 72-5746	PC2 72-1735

** Note: An 's' after the gauge size refers to a special needle size, see chart on page 52.*

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. Cannot substitute different size needles. Syringes supplied individually.

7000 Series Modified Microliter™ Syringes

ORDER #	Volume	Terminus	Point Style	Gauge	KH Repair Kit
PC2 72-1736	0.5 µl	KH	2	25	PC2 72-1749
PC2 72-1737	1 µl	KH	2	25s	PC2 72-1750
PC2 72-1738	1 µl	KH	2	22s	PC2 72-1751
PC2 72-1739	2 µl	KH	2	25	PC2 72-1752
PC2 72-1740	2 µl	KH	2	23	PC2 72-1753
PC2 72-1741	5 µl	KH	2	24	PC2 72-1754
PC2 72-1742	0.5 µl	KH	3	32	PC2 72-1755
PC2 72-1743	0.5 µl	KH	3	25	PC2 72-1756
PC2 72-1744	1 µl	KH	3	25s	PC2 72-1757
PC2 72-1745	1 µl	KH	3	22s	PC2 72-1758
PC2 72-1746	2 µl	KH	3	25	PC2 72-1759
PC2 72-1747	2 µl	KH	3	23	PC2 72-1760
PC2 72-1748	5 µl	KH	3	24	PC2 72-1761

** Note: An 's' after the gauge size refers to a special needle size, see chart on page 52.*

1700 Series GASTIGHT® Syringes

PTFE tipped plungers. Replaceable plungers and needles. Sizes: 10 to 500 µl. Syringes supplied individually. Replacement needles are sold in packages of 6.

1700 Series GASTIGHT® Syringes

					Replacement Parts		
ORDER #	Vol.	Ter.	Point Style	Ga.*	Needle (pkg. of 6)	Plunger	Barrel
PC2 72-1762	10 µl	LT	–	–	–	PC2 72-1785	–
PC2 72-1763	25 µl	LT	–	–	–	PC2 72-1786	–
PC2 72-1764	50 µl	LT	–	–	–	PC2 72-1787	–
PC2 72-1765	100 µl	LT	–	–	–	PC2 72-1788	–
PC2 72-1766	250 µl	LT	–	–	–	PC2 72-1789	–
PC2 72-1767	500 µl	LT	–	–	–	PC2 72-1790	–
PC2 72-1824	5 µl	RN	3	32	PC2 72-5743	–	–
PC2 72-1825	10 µl	RN	3	32	PC2 72-5743	PC2 72-1785	–
PC2 72-1768	10 µl	RN	2	26s	PC2 72-5744	PC2 72-1785	–
PC2 72-1769	25 µl	RN	2	22s	PC2 72-5745	PC2 72-1786	–
PC2 72-1770	50 µl	RN	2	22s	PC2 72-5745	PC2 72-1792	–
PC2 72-1771	100 µl	RN	2	22s	PC2 72-5745	PC2 72-1793	–
PC2 72-1772	250 µl	RN	2	22s	PC2 72-5746	PC2 72-1794	–
PC2 72-1773	500 µl	RN	2	22	PC2 72-7139	PC2 72-1795	–
PC2 72-1774	10 µl	RN	3	22s	PC2 72-5751	PC2 72-1785	–
PC2 72-1775	25 µl	RN	3	22s	PC2 72-5751	PC2 72-1786	–
PC2 72-1776	50 µl	RN	3	22s	PC2 72-5751	PC2 72-1792	–
PC2 72-1777	100 µl	RN	3	22s	PC2 72-5751	PC2 72-1793	–
PC2 72-1778	250 µl	RN	3	22s	PC2 72-5753	PC2 72-1794	–
PC2 72-1779	500 µl	RN	3	22	PC2 72-5752	PC2 72-1795	–
PC2 72-1781	50 µl	TLL	–	–	–	PC2 72-1792	PC2 72-1797
PC2 72-1782	100 µl	TLL	–	–	–	PC2 72-1793	PC2 72-1798
PC2 72-1783	250 µl	TLL	–	–	–	PC2 72-1794	PC2 72-1799
PC2 72-1784	500 µl	TLL	–	–	–	PC2 72-1795	PC2 72-1800
PC2 72-1780	25 µl	TLLX	–	–	–	PC2 72-1791	PC2 72-1796
PC2 72-1901	50 µl	TLLX	–	–	–	PC2 72-1808	PC2 72-1897
PC2 72-1902	100 µl	TLLX	–	–	–	PC2 72-1809	PC2 72-1798
PC2 72-1903	250 µl	TLLX	–	–	–	PC2 72-1810	PC2 72-1799
PC2 72-1904	500 µl	TLLX	–	–	–	PC2 72-1811	PC2 72-1800
PC2 72-1801	10 µl	CX	1/4-28	–	–	–	–
PC2 72-1802	25 µl	CX	1/4-28	–	–	PC2 72-1791	PC2 72-1906
PC2 72-1803	50 µl	CX	1/4-28	–	–	PC2 72-1808	PC2 72-1907
PC2 72-1804	100 µl	CX	1/4-28	–	–	PC2 72-1809	PC2 72-1908
PC2 72-1805	250 µl	CX	1/4-28	–	–	PC2 72-1810	PC2 72-1909
PC2 72-1806	500 µl	CX	1/4-28	–	–	PC2 72-1811	PC2 72-1910

** Note: An 's' after the gauge size refers to a special needle size, see chart on page 52.*

Hamilton™ Glass Syringes (continued)

700 Series Syringes

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

700 Series Syringes**

ORDER #	Volume	Terminus	Point Style	Gauge*	Replacement Needle (pkg. of 6)
PC2 72-1717	5 µl	RN	2	26s	PC2 72-5744
PC2 72-1822	5 µl	RN	3	32	PC2 72-5743
PC2 72-1718	10 µl	RN	2	26s	PC2 72-5744
PC2 72-1823	10 µl	RN	3	32	PC2 72-5743
PC2 72-1719	25 µl	RN	2	22s	PC2 72-5745
PC2 72-1720	50 µl	RN	2	22s	PC2 72-5745
PC2 72-1721	100 µl	RN	2	22s	PC2 72-5745
PC2 72-1722	250 µl	RN	2	22s	PC2 72-5746
PC2 72-1723	500 µl	RN	2	22	PC2 72-7139
PC2 72-1711	10 µl	LT	–	–	–
PC2 72-1712	25 µl	LT	–	–	–
PC2 72-1713	50 µl	LT	–	–	–
PC2 72-1714	100 µl	LT	–	–	–
PC2 72-1715	250 µl	LT	–	–	–
PC2 72-1716	500 µl	LT	–	–	–

** Note: An "s" after the gauge size refers to a special needle size, see chart on page 52.*

1800 Series GASTIGHT® Syringes

Reinforced, PTFE tipped plungers. Replaceable plunger assembly and needle. Syringe sizes from 10 to 250 µl available. Syringes supplied individually.

1800 Series GASTIGHT® Syringes

ORDER #	Volume	Terminus	Point Style	Gauge*	Replacement Needle (pkg. of 6)
PC2 72-1812	10 µl	RN	2	26s	PC2 72-5744
PC2 72-1813	25 µl	RN	2	22s	PC2 72-5745
PC2 72-1814	50 µl	RN	2	22s	PC2 72-5745
PC2 72-1815	100 µl	RN	2	22s	PC2 72-5745
PC2 72-1816	250 µl	RN	2	22s	PC2 72-5746

** Note: An "s" after the gauge size refers to a special needle size, see chart on page 52.*

1000 Series GASTIGHT® Syringes

PTFE tipped plungers. Replaceable plungers and needles sizes: 1 to 100 ml, Terminus: LT, TLL, RN, C. Syringes supplied individually.

1000 Series GASTIGHT® Syringes

					Replacement Parts	
ORDER #	Volume	Ter.	Point Style	Gauge	Needle (pkg. of 6)	Plunger Assembly
PC2 72-1826	1 ml	LT	–	–	–	PC2 72-1894
PC2 72-1827	1.25 ml	LT	–	–	–	PC2 72-1895
PC2 72-1828	2.5 ml	LT	–	–	–	PC2 72-1896
PC2 72-1829	5 ml	LT	–	–	–	PC2 72-1897
PC2 72-1830	10 ml	LT	–	–	–	PC2 72-1898
PC2 72-1831	1 ml	TLL	–	–	–	PC2 72-1894
PC2 72-1832	2.5 ml	TLL	–	–	–	PC2 72-1896
PC2 72-1833	5 ml	TLL	–	–	–	PC2 72-1897
PC2 72-1834	10 ml	TLL	–	–	–	PC2 72-1898
PC2 72-1835	25 ml	TLL	–	–	–	PC2 72-1899
PC2 72-1836	50 ml	TLL	–	–	–	PC2 72-1900
PC2 72-1837	100 ml	TLL	–	–	–	–
PC2 72-1838	1 ml	RN	2	22	PC2 72-7139	PC2 72-1894
PC2 72-1839	2.5 ml	RN	2	22	PC2 72-7139	PC2 72-1896
PC2 72-1840	5 ml	RN	2	22	PC2 72-7139	PC2 72-1897
PC2 72-1841	10 ml	RN	2	22	PC2 72-7139	PC2 72-1898
PC2 72-1842	1 ml	C	–	1/4-28	–	PC2 72-1894
PC2 72-1843	2.5 ml	C	–	1/4-28	–	PC2 72-1896
PC2 72-1844	5 ml	C	–	1/4-28	–	PC2 72-1897
PC2 72-1845	10 ml	C	–	1/4-28	–	PC2 72-1898

Constant Rate Syringes

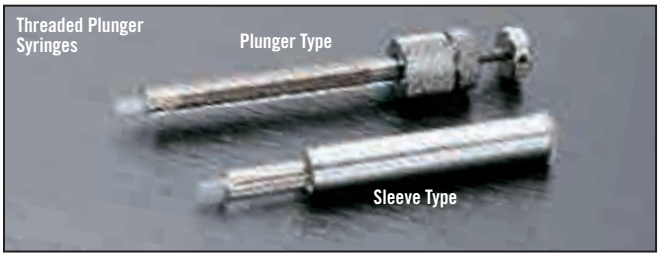
Spring-driven plunger injects samples at a constant rate. Incremental volumes are selectable with mm precision. Volumes: 20, 50, 200 µl. Syringes supplied individually.

Order #	Product	Gauge*	Length	Point Style
PC2 72-1854	Constant Rate Syringe, 20 µl	22s	2 in	3
PC2 72-1855	Constant Rate Syringe, 50 µl	22	2 in	3
PC2 72-1856	Constant Rate Syringe, 200 µl	22	2 in	3

** Note: An "s" after the gauge size refers to a special needle size, see chart on page 52.*

Specialty Syringes and Accessories

Threaded Plunger Syringes



For applications requiring extremely precise plunger movement or minute fluid manipulation, LT (Luer Tip) Terminus Volumes from 25 µl to 1 ml. Syringes supplied individually.

Threaded Plunger Syringes

ORDER #	Volume	Description	Dispense Volume
PC2 72-1857	25 µl	Sleeve Type	0.33 µl/revolution
PC2 72-1859	100 µl	Sleeve Type	1.32 µl/revolution
PC2 72-1862	500 µl	Plunger Type	5.29 µl/revolution
PC2 72-1863	1 ml	Plunger Type	13.23 µl/revolution

Cadence Science (formerly Popper & Sons) Micro-Mate Glass Syringes

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

Cadence Science (formerly Popper & Sons) Micro-Mate Glass Syringes

ORDER #	Syringe Size	ORDER #	Syringe Size
PC2 55-0913	2 cc	PC2 55-0947	20 cc
PC2 55-0921	5 cc	PC2 55-0954	30 cc
PC2 55-0939	10 cc	PC2 55-0962	50 cc

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 (Luer Lock) with a 12 gauge bore of 0.223 cm (0.088 in). 100 ml size only. Syringes supplied individually.

Order #	Product
PC2 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		
ORDER #	Volume	700	1700	7000
PC2 72-1868	0.5 to 5 µl			•
PC2 72-1867	5 to 10 µl	•		
PC2 72-1867	5 to 10 µl		•	
PC2 72-1868	25 to 500 µl	•		
PC2 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 packages of 10. Cleaning concentrate is sold separately.

Order #	Product	
	Cleaning Wires	
	To Clean Needle Gauge	Wire Size OD
PC2 72-1873	23s, 26s, 31 to 33	0.0762 mm (0.00300 in)
PC2 72-1874	26s, 31 to 33	0.0889 mm (0.00350 in)
PC2 72-1875	22s, 25s, 28 to 30	0.1262 mm (0.00497 in)
PC2 72-1876	27	0.1674 mm (0.00659 in)
PC2 72-1877	24 to 26	0.2070 mm (0.00815 in)
PC2 72-1878	22, 23	0.3066 mm (0.01207 in)
PC2 72-1879	Cleaning Concentrate, 70 ml	
PC2 72-1880	Cleaning Concentrate, 500 ml	
PC2 72-1872	All Cleaning Wires and 70 ml of Cleaning Concentrate	

Removable (RN) Adapters

Provides connection of Luer fittings to RN syringes > 250 µl.

Order #	Product
PC2 72-1869	RN Hub to Female Luer
PC2 72-1870	RN Hub to Male Luer
PC2 72-1871	RN Hub to Male Luer Lock

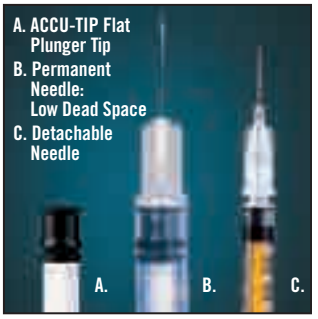
Plastic Syringes

Super Syringes

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

Order #	Volume	Terminus
PC2 72-1846	500 ml	TLL
PC2 72-1847	1000 ml	TLL
PC2 72-1848	1500 ml	TLL
PC2 72-1849	2000 ml	TLL

Single Use Monoject® Plastic Syringes



APPLICATIONS

- Syringe volumes from 0.3 to 1 cc
- Rigid or blister packaging
- Permanent or detachable needle
- ACCU-TIP 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.

Single Use Monoject Plastic Syringes

						Box of 100	Case of Syringes	
Volume	**Needle Gauge**	**Needle Length**	**Needle* Attachment**	**Pack Type**	**Safety Shield**	**ORDER #**	**ORDER #**	**Qty**
0.3 cc	29	0.5 in	P	Blister	–	**PC2 72-2419**	**PC2 72-2437**	300
0.3 cc	29	0.5 in	P	Rigid	Yes	**PC2 72-2420**	**PC2 72-2438**	500
0.5 cc	28	0.5 in	P	Rigid	–	**PC2 72-2421**	**PC2 72-2439**	500
0.5 cc	28	0.5 in	P	Blister	–	**PC2 72-2422**	**PC2 72-2440**	300
0.5 cc	29	0.5 in	P	Blister	–	**PC2 72-2424**	**PC2 72-2442**	300
0.5 cc	29	0.5 in	P	Rigid	Yes	**PC2 72-2425**	**PC2 72-2443**	500
1 cc	25	0.625 in	D	Rigid	–	**PC2 72-2426**	**PC2 72-2444**	500
1 cc	25	0.625 in	P	Rigid	–	**PC2 72-2427**	**PC2 72-2445**	500
1 cc	25	0.625 in	P	Rigid	Yes	–	**PC2 72-2447**	500
1 cc	26	0.375 in	D	Rigid	–	**PC2 72-2429**	**PC2 72-2448**	500
1 cc	27	0.5 in	D	Rigid	–	**PC2 72-2430**	**PC2 72-2449**	500
1 cc	28	0.5 in	P	Rigid	–	**PC2 72-2432**	**PC2 72-2451**	500
1 cc	28	0.5 in	P	Blister	–	**PC2 72-2433**	**PC2 72-2452**	500
1 cc	28	0.5 in	P	Rigid	Yes	–	**PC2 72-2454**	500
1 cc	29	0.5 in	P	Blister	–	**PC2 72-2435**	**PC2 72-2455**	300
1 cc	29	0.5 in	P	Rigid	Yes	**PC2 72-2436**	**PC2 72-2456**	500

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

Plastic Syringes (continued)

Becton Dickinson Plastic Syringes

These individually packaged plastic sterile syringes come standard with a Luer Lock connector. They are available in six sizes. See the table below for size and quantity information.

Becton Dickinson Plastic Syringes

ORDER #	Syringe Size	Graduation	Qty./Box
PC2 59-8377	3 ml	1/10 ml	100
PC2 59-8378	5 ml	1/5 ml	125
PC2 59-8379	10 ml (3/4 oz)	1/5 m (1/8 oz)	100
PC2 59-8380	20 ml (1 oz)	1 ml (1/8 oz)	40
PC2 59-8381	30 ml (2 oz)	1 ml (1/4 oz)	40
PC2 59-8382	60 ml	1 ml	40

Threaded Unions, Ferrules and Nuts

Threaded unions are used to join any 1/4-28 male threaded fitting to tubing. These adapters are ideal for connecting threaded Chem terminus Hamilton Gastight® syringes, see pages 52 to 55. PEEK Unions should be used for high pressure applications. ETFE Unions should be used with softer tubing types like FEP, PFA, and PVDF Tubing, see pages 95 and 98. Delrin unions can be used with most other tubing. Each union has 1/4-28 female threads. PEEK and ETFE Unions come complete with two ferrules and nuts. Ferrules and nuts must be purchased separately for the Delrin and Polypropylene Unions.

Order #	Fitting Type	Qty.	Material	For Tubing OD
PC2 72-2851	Union, Complete	1	PEEK	1/16 in
PC2 72-2852	Union, Complete	1	PEEK	1/8 in
PC2 72-2853	Union, Complete	1	ETFE	1/16 in
PC2 72-2854	Union, Complete	1	ETFE	1/8 in
PC2 72-2855	Union, Only	5	Delrin	—
PC2 72-2856	Union, Only	5	Polypropylene	—
PC2 72-2857	Ferrule	10	ETFE	1/16 in
PC2 72-2858	Ferrule	10	Polypropylene	1/16 in
PC2 72-2859	Ferrule	10	ETFE	1/8 in
PC2 72-2860	Nut	5	PEEK	1/16 in
PC2 72-2861	Nut	10	ETFE	1/16 in
PC2 72-2862	Nut	10	Delrin	1/16 in
PC2 72-2863	Nut	10	Polypropylene	1/16 in
PC2 72-2864	Nut	5	PEEK	1/8 in
PC2 72-2865	Nut	10	ETFE	1/8 in
PC2 72-2866	Nut	10	Delrin	1/8 in
PC2 72-2867	Nut	10	Polypropylene	1/8 in

Sterile Monoject® Syringes without Needles*

		Box of Syringes		Case of Syringes	
Volume	Tip	ORDER #	Qty.	ORDER #	Qty.
1 ml	Luer (long barrel)	PC2 72-2359	100	PC2 72-2379	500
1 ml	Luer	PC2 72-2360	100	PC2 72-2380	500
3 ml	Luer	PC2 72-2361	100	PC2 72-2381	1000
6 ml	Luer	PC2 72-2362	50	PC2 72-2382	500
6 ml	Luer Lock	PC2 72-2363	50	PC2 72-2383	500
12 ml	Luer	PC2 72-2364	80	PC2 72-2384	480
12 ml	Luer Lock	PC2 72-2365	80	PC2 72-2385	480
12 ml	Eccentric Luer	PC2 72-2366	80	PC2 72-2386	480
20 ml	Luer	PC2 72-2367	50	PC2 72-2387	300
20 ml	Luer Lock	PC2 72-2368	50	PC2 72-2388	300
20 ml	Eccentric Luer	PC2 72-2369	50	PC2 72-2389	300
35 ml	Luer	PC2 72-2370	30	PC2 72-2390	180
35 ml	Luer Lock	PC2 72-2371	30	PC2 72-2391	180
35 ml	Eccentric Luer	PC2 72-2372	30	PC2 72-2392	180
35 ml	Catheter	PC2 72-2373	30	PC2 72-2393	180
60 ml	Luer	PC2 72-2374	20	PC2 72-2394	100
60 ml	Luer Lock	PC2 72-2375	20	PC2 72-2395	100
60 ml	Eccentric Luer	PC2 72-2376	20	PC2 72-2396	100
60 ml	Catheter	PC2 72-2377	20	PC2 72-2397	100
60 ml	Toomey	PC2 72-2378	20	PC2 72-2398	100
140 ml	Luer Lock	–	–	PC2 72-2399	20

Non-Sterile Monoject® Syringes without Needles*

		Box of Syringes		Case of Syringes	
Volume	Tip	ORDER #	Qty.	ORDER #	Qty.
3 ml	Luer	PC2 72-2400	250	PC2 72-2408	1000
6 ml	Luer	PC2 72-2401	100	PC2 72-2409	500
12 ml	Luer	PC2 72-2402	100	PC2 72-2410	500
12 ml	Eccentric Luer	PC2 72-2403	100	PC2 72-2411	500
20 ml	Luer	PC2 72-2404	50	PC2 72-2412	250
20 ml	Eccentric Luer	PC2 72-2405	50	PC2 72-2413	250
35 ml	Luer	PC2 72-2406	25	PC2 72-2414	100
60 ml	Luer	PC2 72-2407	31	PC2 72-2415	155
140 ml	Luer	–	–	PC2 72-2416	20
140 ml	Luer Lock	–	–	PC2 72-2417	20
140 ml	Catheter	–	–	PC2 72-2418	20

Choosing the Right Pump for Your Application & Budget

KEY FEATURES

- Broad selection of pumps for every application
- Wide range of flow rates ml/hr to L/min
- Single and multi-channel models available with up to 24 channels
- Continuous delivery and batch mode dispensing

PERISTALTIC PUMP QUESTIONS

- How many channels (tubes) will be used simultaneously?
- What size tubing will be used (inner diameter)?
- What flow rate(s) will be used?
- What is the total volume to be delivered?
- Do you need continuous flow?
- Does the pump need to be battery operated?
- Do you need to control the pump with a computer?
- Do you need analog control?
- Does the pump need to have TTL capabilities (external control of valves, use of footswitch etc)?

Peristaltic Pump Selection Guide

PUMP MODEL	NEW Model P-70	NEW Model P-230	NEW Model P-1500	MPII	Pump 66	Pump 77	Model 720
ORDER #	PC2 70-7000	PC2 70-7001	PC2 70-7002	PC2 70-2027	PC2 55-7766	PC2 55-7777	PC2 72-0001
NUMBER OF CHANNELS	5	4	1	1 to 2	1	1	1 to 2
NUMBER OF ROLLERS	8	8	4	4	3	3	3
TUBE SIZE (INNER DIAMETER)	0.13 to 2.79 mm (0.005 to 0.11 in)	0.13 to 3.17 mm (0.005 to 0.13 in)	0.8 to 4.8 mm (0.03 to 0.19 in)	1.6 mm (1/16 in)	1.6 and 3.2 mm (1/16 and 1/8 in)	3.2 and 6.4 mm (1/8 and 1/4 in)	0.38 to 2.4 mm (0.015 to 0.093 in)
FLOW RATE (ML/MIN/PER CHANNEL):							
Minimum	0.001	0.001	0.01	0.8	0.01	0.01	0.07
Maximum	70	230	1,500	12.25/24.50	210	750	18
COMPUTER CONTROL	Yes (USB)	Yes (USB)	Yes (USB)	No	Yes (RS-232)	Yes (RS-232)	No
TTL CONTROL	Yes	Yes	Yes	No	Yes	Yes	No
ANALOG CONTROL	Yes	Yes	Yes	No	No	No	Yes
POWER	100-250 VAC, 50/60 Hz	100-250 VAC, 50/60 Hz	100-250 VAC, 50/60 Hz	115-230 VAC, 50/60 Hz	115/230 VAC, 50/60 Hz	115/230 VAC, 50/60 Hz	120 VAC, 50 Hz, 230 VAC, 60 Hz
BATTERY BACKUP	No	No	No	No	No	No	No
DIMENSIONS (H x W x D)	11.5 x 25.4 x 11.8 cm (4.5 x 10 x 4.63 in)	16 x 23.6 x 11.8 cm (6.3 x 9.3 x 4.6 in)	11.5 x 24.1 x 11.8 cm (4.5 x 9.5 x 4.6 in)	18.9 x 11.4 x 10.5 cm (3.5 x 4.5 x 4 in)	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)	6.4 x 5.7 x 10.2 cm (2.5 x 2.25 x 4 in)
WEIGHT	2.27 kg (10.55 lbs)	2.5 kg (5.5 lbs)	2.5 kg (5.5 lbs)	0.96 kg (2.1 lbs)	3.53 kg (7.85 lbs)	5.1 kg (11.25 lbs)	375 g (13.2 oz)
CATALOG PAGE	62	62	62	64	65	65	66

** Depends upon Pump Drive.*

Choosing the Right Pump for Your Application & Budget
(continued)

Harvard Apparatus offers an extensive selection of peristaltic 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. The following table was designed to answer most questions regarding our continuous flow pumps. Please contact our technical support department for further assistance.

Peristaltic and Continuous Flow Pumps

Traditional peristaltic pumps utilize a series of rollers 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 Mini-Peristaltic Pump (MPII, see page 64) features two speed ranges, reversability and dual channel pumping at a very reasonable price. Many pumps offer external control either through the input of an analog signal proportional to the speed or by RS-232 (serial) communication.

	Model 720	Model 720	IP/IPC	REGLO Analog and Digital	Ecoline	Ecoline 4 and 8-Channel	Gentle Pump Heads	Pump Head 380AD	SB Pump Head
	PC2 72-4048	**PC2 72-4049**	**SEE PAGE 72**	**SEE PAGE 67**	**SEE PAGE 70**	**SEE PAGE 71**	**SEE PAGE 76**	**PC2 73-3035**	**SEE PAGE 78**
	1 to 2	1 to 2	4 to 24	2 or 4	1	4 or 8	1	1	1 to 3
	3	3	8	6, 8 or 12	2 or 3	6 or 12	2 or 3	3	6
	0.38 to 2.4 mm (0.015 to 0.093 in)	0.38 to 2.4 mm (0.015 to 0.093 in)	0.13 to 3.17 mm (0.01 to 0.12 in)	0.13 to 3.1 mm (0.01 to 0.12 in)	0.8 to 11.1 mm (0.03 to 0.44 in)	0.13 to 3.17 mm (0.01 to 0.12 in)	1.6 to 11.1 mm (0.06 to 0.44 in)	0.8 to 11.1 mm (0.03 to 0.44 in) or 4.8 to 6.4 mm (0.19 to 0.25 in)	0.8 to 6.4 mm (0.03 to 0.25 in) or 3.2 to 8.0 mm (0.13 to 0.31 in)
	0.0008	0.0002	0.002	0.001	1.7	0.005	0.45	0.41	0.09 or 1.1
	0.20	0.058	44	68	5,400	150	3,700	1,500	870 or 1,100
	No	No	Yes (RS-232)	Yes (Digital)	No	No	n/a*	n/a*	n/a*
	No	No	Yes	No	No	No	n/a*	n/a*	n/a*
	Yes	Yes	Yes	Yes (Analog)	Yes	Yes	n/a*	n/a*	n/a*
	120 VAC, 50 Hz, 230 VAC, 60 Hz	120 VAC, 50 Hz, 230 VAC, 60 Hz	120 VAC, 50 Hz, 230 VAC, 60 Hz	115/230 VAC, 50/60 Hz	115/230 VAC, 50/60 Hz	115/230 VAC, 50/60 Hz	n/a*	n/a*	n/a*
	9 V Lithium Battery up to 30 hours	9 V Lithium Battery up to 30 hours	No	No	No	No	n/a*	n/a*	n/a*
	6.4 x 5.7 x 10.2 cm (2.5 x 2.25 x 4 in)	6.4 x 5.7 x 10.2 cm (2.5 x 2.25 x 4 in)	n/a*	14 x 10 x 19 cm (5.3 x 3.9 x 7.5 in)	14 x 17 x 29 cm (5 x 7 x 11 in)	14 x 17 x 31 cm (5 x 7 x 12 in)	n/a*	n/a*	n/a*
	375 g (13.2 oz)	375 g (13.2 oz)	n/a*	2.1 kg (4.6 lbs)	5.3 kg (11.7 lbs)	5.5 kg (12.1 lbs)	n/a*	n/a*	n/a*
	66	66	72	67	70	71	76	77	78

NEW Harvard Peristaltic Pumps

Pump with P-1500
Motor Drive
PC2 70-7005

Pump with P-70
Motor Drive
PC2 70-7003

Pump with P-230
Motor Drive
PC2 70-7004

Harvard Peristaltic Pump
Control Box
PC2 70-7006

KEY FEATURES

- Remote Design
- Interchangeable Pumps
- Programmable

The **NEW** Harvard Peristaltic Pump series offers unparalleled accuracy, reproducibility, and ease of use over a broad range of flow rates. Other benefits include:

- **The ability to separate the motor drive from the controller to facilitate use and save space in incubators and fume hoods**
- **A library of tubing sizes is stored in the pump's memory minimizing set up time**
- **Custom tubing can be used allowing complete flexibility**
- **A full range of interchangeable motor drives to allow for economical ease of use over a broad flow rate range.**

The Harvard Peristaltic Pump consists of a control unit and a series of motor drives. The pump can deliver solutions over a range of flow rates from 0.001 to 1,500 ml/min depending on the motor drive used. Three interchangeable motor drive modules provide flow over the following ranges:

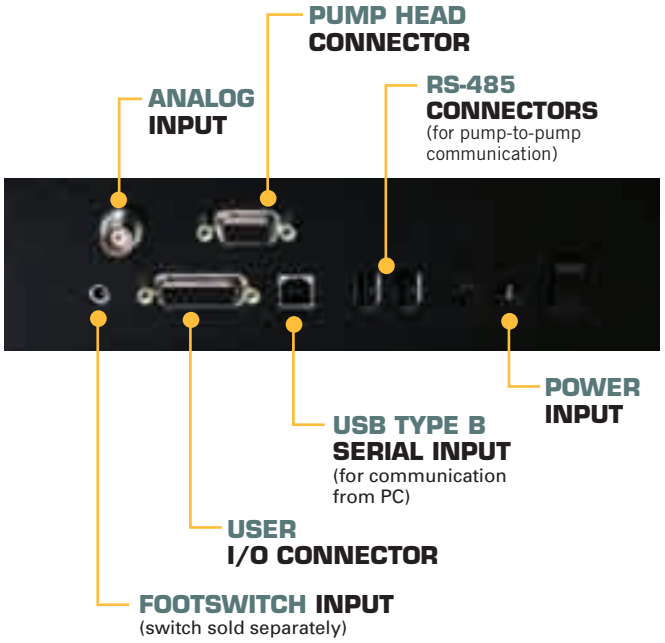
- **P – 70 drive provides flow rates from 0.001 to 70 ml/min**
- **P – 230 drive provides flow rates from 0.001 to 230 ml/min**
- **P – 1500 drive provides flow rates from 0.01 to 1,500 ml/min**

A complete range of programmable functions allow the pump to be easily adapted to a wide range of dispensing applications. The pump has pre-programmed flow profiles for:

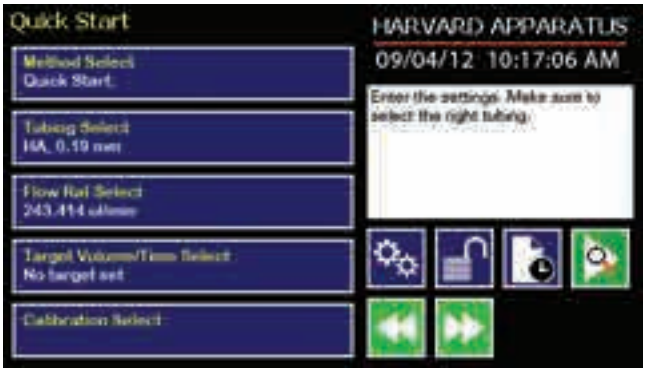
- **Constant Flow**
- **Flow Ramps**
- **Pulsatile Flow**
- **Concentration Based Fluid Delivery**

In addition to the flow profiles, the pump has advanced user options that permit the pump to be controlled by a PC from its USB inputs as well as a range of options such as:

- **Remote initiated start/stop times.**
- **Communication with external devices through 15-pin I/O**
- **Constant pressure through BNC**



NEW Harvard Peristaltic Pumps (continued)



Harvard Peristaltic Pump Quick Start Screen

All settings can easily be saved as user generated methods in the pump's memory. The method can be easily recalled and run very quickly, saving researchers valuable time.

Connectivity to a wide range of external input or output devices is easily accomplished. A constant pressure mode may be utilized in conjunction with a pressure transducer.

The pump will automatically rotate at the proper RPM for the tube selection and flow rate chosen. To further increase the accuracy, Harvard Peristaltic Pumps offer a rapid calibration routine to further optimize flow accuracy by entering a measured volume of fluid collected.

OTHER CAPABILITIES INCLUDE:

- Single Channel or combined channel mode for setting flow rate
- Timed Dispense: Dispenses for a fixed time at a set flow rate
- Volume Dispense: Dispenses a fixed volume on start
- Foot Switch Control Option
- Analog Control Option
- Biodirectional Delivery

Harvard Peristaltic Pump Run Screen

Harvard Peristaltic Pump Specifications, Control Box and Pump with Motor Drive

DESCRIPTION	PUMP WITH P-70 MOTOR DRIVE	PUMP WITH P-230 MOTOR DRIVE	PUMP WITH P-1500 MOTOR DRIVE
Type	8 rollers, 5 channels	8 rollers, 4 channels	4 rollers, 1 channel
Accuracy	±1.0%	±1.0%	±1.0%
TTL Connector	15-pin D-sub	15-pin D-sub	15-pin D-sub
Computer Interface	USB Type 'B'	USB Type 'B	USB Type 'B
Pump-to-Pump	IEEE 1394	IEEE 1394	IEEE 1394
Back pressure	15 psi	15 psi	30 psi
Tubing ID	0.13 to 2.79 mm (0.005 to 0.11 in)	0.13 to 3.17 mm (0.005 to 0.13 in)	0.8 to 4.8 mm (0.03 to 0.19 in)
Flow Rate Range	0.001 to 70 ml/min	0.001 to 230 ml/min	0.01 to 1,500 ml/min
Dimensions: Control Box	20.7 x 13 x 9.6 cm (8.13 x 5.13 x 3.75 in)	20.7 x 13 x 9.6 cm (8.13 x 5.13 x 3.75 in)	20.7 x 13 x 9.6 cm (8.13 x 5.13 x 3.75 in)
Dimensions: Pump Head	11.5 x 25.4 x 11.8 cm (4.5 x 10 x 4.63 in)	16 x 23.6 x 11.8 cm (6.3 x 9.3 x 4.63 in)	11.5 x 24.1 x 11.8 cm (4.5 x 9.5 x 4.63 in)
Weight	4.7 kg (10.5 lbs)	5 kg (11 lbs)	5 kg (11 lbs)
Pump Voltage	30 VDC, 1.67 A	30 VDC, 1.67 A	30 VDC, 1.67 A
Power Supply	100-250 VAC, 50/60 Hz	100-250 VAC, 50/60 Hz	100-250 VAC, 50/60 Hz
For Compatible Tubing	See page 84	See page 83	See page 84
ORDER #	PC2 70-7000	PC2 70-7001	PC2 70-7002

Replacement Parts

ORDER #	PRODUCT
PC2 70-7003	P-70 Motor Drive, 8 rollers, 5 channel
PC2 70-7004	P-230 Motor Drive, 8 rollers, 4 channel
PC2 70-7005	P-1500 Motor Drive, 4 rollers, 1 channel
PC2 70-7006	Control Box for all P Series Motor Drives
PC2 70-0604	Replacement Cartridge/Cassette for P-70
PC2 70-3052	Replacement Cartridge/Cassette for P-230

MP II Mini-Peristaltic Pump

KEY FEATURES

- Continuous low flow rates ideal for:
  - Slow perfusion studies
  - Controlled animal feeding
- Pump can take one or two tubes simultaneously, 1/16 inch ID
- 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 of the PC2 55-4148 Pump Head Tubing Pieces are included with the pump. Additional Pump Head Tubing Pieces (PC2 55-4148) may be purchased separately.

Two front panel controls provide flow rates from approximately 0.8 to 24.5 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 in ml/min Flow Rates

	WITH ONE TUBE		WITH TWO TUBES	
Switch Setting	Minimum	Maximum	Minimum	Maximum
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

MPII 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 lbs)
TUBING ID	1/16 in

Order #	Product
PC2 70-2027	MPII, 115/230 VAC, 50/60 Hz
PC2 55-4148	Pump Head Tubing Pieces. These Silicone Pump Head Tubing Pieces Have Connectors on Each End for 1/16 in ID Tubing 2.5 in, pkg. of 10

Harvard Apparatus Peristaltic Pump 66 and 77

Peristaltic Pumps
66 and 77

KEY FEATURES

- 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.

Peristaltic Pump 66 and 77 Specifications		
TYPE	3 roller rotary peristaltic, single channel	
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	
PUMP:	**Small 66 Pump**	**Large 77 Pump**
Tubing ID*	1.6 and 3.2 mm (0.0625 and 0.125 in)	3.2 and 6.4 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 lbs)	5.1 kg (11.25 lbs)

Order #	Product
PC2 55-7766	Peristaltic Pump 66
PC2 55-7777	Peristaltic Pump 77
PC2 70-2022	RS-232 Connection Cable; Computer to Pump
PC2 72-2478	Daisy Chain Cable; Pump to Pump, 1.8 m (7 ft)
PC2 55-7760	Daisy Chain Cable; Pump to Pump, 0.6 m (2 ft)
PC2 55-7757	Feedback Loop Connector for Mettler Scale
PC2 55-7758	Feedback Loop Connector for Ohaus Scale
PC2 55-7759	Feedback Loop Connector for Sartorius Scale

**Note: Tygon® E-1000 or comparable tubing recommended, see page 94.*

Harvard/Instech Model 720

Compact Peristaltic Pumps and Tubing

KEY FEATURES

- Continuous infusion
- Battery back-up (30 hrs)
- Compact pump
- Minimal electromagnetic radiation

The Instech Model 720 Compact Peristaltic Pumps are a stand-alone pump series with flow rates of 0.2 µl/min to 18 ml/min (0.04 to 1100 ml/hr) depending upon the pump and tubing selected. These pumps deliver the accurate low flow rates of syringe pumps without the limits on delivered volume. They are ideal for animal IV infusion, tissue perfusion, and other low-flow laboratory applications.

Instech offers this pump with four different motors; choose the motor and tube set that best match your flow rate requirements. In general, use the standard PC2 61-0098 for flows between 0.05 and 1 ml/min, the lower flow PC2 72-4048 for rates between 5 and 100 µl/min, the ultra low flow PC2 72-4049 for rates as low as 0.2 µl/min, and then the higher-flow PC2 72-0001 for rates up to 18 ml/min (1 l/hr). With a given tube set, the pump performs best over a 10:1 flow control range.

The pump's analog circuitry has been carefully designed to minimize electromagnetic radiation; for this reason, the pump is often used for tissue perfusion even in the presence of sensitive intracellular recordings. It is also an ideal pump for applications which require limited size or weight, the versatility of single and dual tubes sets and/or external analog control.

An internal 9V lithium battery (supplied with PC2 61-0098, PC2 72-4048 and PC2 72-4049) will run the pump for up to 30 hours, protecting your experiment in the event of a power failure. Due to its power requirements, the high flow version (PC2 72-0001) 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.

Tube sets must be purchased separately. Please see our website or contact technical support if you need assistance choosing the right tube set. 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.

Model 720 Specifications

ACCURACY	±5%
REPEATABILITY	±3%
FLOW CONTROL RANGE	20:1
POWER SOURCE	Universal 15 VDC 1A adapter, 2.5 mm male plug & tip
DIMENSIONS, H x W x D	6.4 x 5.7 x 10.2 cm (2.5 x 2.3 x 4 in)
WEIGHT	375 g (1 lbs)
VOLTAGE RANGE	Universal input 100-240 VAC, 50/60 Hz

***Tube sets are not supplied with the pump. They must be purchased separately.*

Tube Sets

A wide variety of tube sizes, tube materials and connector types allows you to tailor your peristaltic pump to your particular application.

Tube sets typically last about one month under continuous operation. Dual channel tube sets place more stress on the pump than do single channel tube sets, which may shorten the life of your pump's motor.

Silicone Tubing Sets

Order #	Product
PC2 61-0241	1-Ch, Female Luer to 22 ga, pkg. of 5
PC2 61-0242	1-Ch, Female Luer to 20 ga, pkg. of 5
PC2 61-0243	1-Ch, 0.062" ID Barbs, 0.8 ml/hr, pkg. of 5
PC2 61-0244	1-Ch, 0.062" ID Barbs, 5 ml/hr, pkg. of 5
PC2 61-0245	2-Ch, 0.062" ID Barbs, 3 ml/hr, pkg. of 5

Flow Rate Ranges

	ORDER #	ORDER #	ORDER #	ORDER #
Tube ID	**PC2 72-4049**	**PC2 72-4048**	**PC2 61-0098**	**PC2 72-0001**
0.015"	0.2 - 2.2 µl/min	0.8 – 7.5 µl/min	8 - 83 µl/min	70 - 700 µl/min
0.020"	0.4 - 4.6 µl/min	1.6 - 16 µl/min	18 - 180 µl/min	0.15 - 1.5 ml/min
0.031"	0.9 - 8.7 µl/min	3 - 30 µl/min	35 - 350 µl/min	0.3 – 2.8 ml/min
0.062"	3 - 30 µl/min	10 - 100 µl/min	125 - 1,250 µl/min	0.9 – 9 ml/min
0.093"	6 - 58 µl/min	20 - 200 µl/min	240 - 2,400 µl/min	1.8 - 18 ml/min

REGLO Analog Peristaltic Pumps

PC2 73-2951

KEY FEATURES

- Small footprint
- Low pulsation with 12 rollers
- High repeatability
- 2 or 4 channels with 6, 8 or 12 rollers

REGLO Analog 2 Channel, 6, 8 or 12 Roller Pump

Roller head with 2 snap-on MS/CA Click 'n' Go Cassettes included for 3-stop collared tubing. See page 82.

REGLO Analog 4 Channel, 6, 8 or 12 Roller Pump

Roller head with 4 snap-on MS/CA Click 'n' Go Cassettes included for 3-stop collared tubing. See page 82.

REGLO Specifications

REGLO Analog 2 Channel

	MS-2/6-160	MS-2/8-160	MS-2/12-160
CHANNELS	2	2	2
PUMP ROLLERS	6	8	12
FLOW RATES, MINIMUM	0.002 ml/min	0.002 ml/min	0.002 ml/min
FLOW RATES, MAXIMUM	68 ml/min	57 ml/min	38 ml/min
SPEED RANGE	1.6 to 160 rpm		
MAINS CONNECTION	115 VAC / 50 Hz or 230 VAC /50 Hz		
POWER CONSUMPTION	20 W		
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		
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	143 x 100 x 178 mm (5.6 x 3.9 x 7.0 in)		
WEIGHT	2.0 kg (4.4 lbs)		

REGLO Specifications

REGLO Analog 4 Channel

	MS-4/6-100	MS-4/8-100	MS-4/12-100
CHANNELS	4	4	4
PUMP ROLLERS	6	8	12
FLOW RATES, MINIMUM	0.002 ml/min	0.002 ml/min	0.001 ml/min
FLOW RATES, MAXIMUM	43 ml/min	35 ml/min	24 ml/min
SPEED RANGE	1 to 100 rpm		
MAINS CONNECTION	115 VAC / 60 Hz or 230 VAC /50 Hz		
POWER CONSUMPTION	20 W		
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		
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	143 x 100 x 190 mm (5.3 x 3.9 x 7.5 in)		
WEIGHT	2.1 kg (4.6 lbs)		

Order #	Product
PC2 73-3054	Replacement MS/CA Click 'n' Go Cassette
PC2 73-3055	MS/CA Pressure Lever Cassette
PC2 73-2951	REGLO Analog 2 Channel MS-2/6-160, 115 VAC, 60 Hz
PC2 73-2952	REGLO Analog 2 Channel MS-2/8-160, 115 VAC, 60 Hz
PC2 73-3294	REGLO Analog 2 Channel MS-2/12-160, 115 VAC, 60 Hz
PC2 73-2447	REGLO Analog 2 Channel MS-2/6-160, 230 VAC, 50 Hz
PC2 73-2448	REGLO Analog 2 Channel MS-2/8-160, 230 VAC, 50 Hz
PC2 73-3295	REGLO Analog 2 Channel MS-2/12-160, 230 VAC, 50 Hz
PC2 73-2953	REGLO Analog 4 Channel MS-4/6-100, 115 VAC, 60 Hz
PC2 73-0113	REGLO Analog 4 Channel MS-4/8-100, 115 VAC, 60 Hz
PC2 73-3292	REGLO Analog 4 Channel MS-4/12-100, 115 VAC, 60 Hz
PC2 73-2449	REGLO Analog 4 Channel MS-4/6-100, 230 VAC, 50 Hz
PC2 73-0114	REGLO Analog 4 Channel MS-4/8-100, 230 VAC, 50 Hz

REGLO Digital Programmable Peristaltic Pumps

KEY FEATURES

- Flow rates from 0.002 to 68 ml/min
- Snap-on MS/CA click 'n' go cassette included
- RS-232 interface for PC control
- 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

REGLO Digital 2 Channel, 6, 8 or 12 Roller Pumps

Tube-bed with 2 snap-on MS/CA Click 'n' Go Cassettes included for 3-stop collared tubing. See page 82.

REGLO Digital 4 Channel, 6, 8 or 12 Roller Pumps

Tube-bed with 4 snap-on MS/CA Click 'n' Go Cassettes included for 3-stop collared tubing. See page 82.

REGLO Specifications

REGLO Digital 2 Channel			
	MS-2/6-160	**MS-2/8-160**	**MS-2/12-160**
CHANNELS	2	2	2
PUMP ROLLERS	6	8	12
FLOW RATES, MINIMUM	0.003 ml/min	0.002 ml/min	0.002 ml/min
FLOW RATES, MAXIMUM	68 ml/min	57 ml/min	38 ml/min
SPEED RANGE	1.6 to 160 rpm		
MAINS CONNECTION	115 VAC / 60 Hz or 230 VAC /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)		
WEIGHT	2.0 kg (4.4 lbs)		
REGLO Digital 4 Channel			
	MS-4/6-100	**MS-4/8-100**	**MS-4/12-100**
CHANNELS	4	4	4
PUMP ROLLERS	6	8	12
FLOW RATES, MINIMUM	0.002 ml/min	0.002 ml/min	0.001 ml/min
FLOW RATES, MAXIMUM	43 ml/min	35 ml/min	24 ml/min
SPEED RANGE	1 to 100 rpm		
MAINS CONNECTION	115 V / 60 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 190 mm (5.3 x 3.9 x 7.5 in)		
WEIGHT	2.1 kg (4.6 lbs)		

Order #	Product	Order #	Product
PC2 73-2948	MS-2/6-160 REGLO Digital 2 Channel, 115 VAC, 60 Hz	**PC2 73-3296**	MS-4/12-100 REGLO Digital 4 Channel, 115 VAC, 60 Hz
PC2 73-2949	MS-2/8-160 REGLO Digital 2 Channel, 115 VAC, 60 Hz	**PC2 73-2446**	MS-4/6-100 REGLO Digital 4 Channel, 230 VAC, 50 Hz
PC2 73-3298	MS-2/12-160 REGLO Digital 2 Channel, 115 VAC, 60 Hz	**PC2 73-0100**	MS-4/8-100 REGLO Digital 4 Channel, 230 VAC, 50 Hz
PC2 73-2444	MS-2/6-160 REGLO Digital 2 Channel, 230 VAC, 50 Hz	**PC2 73-3297**	MS-4/12-100 REGLO Digital 4 Channel, 230 VAC, 50 Hz
PC2 73-2445	MS-2/8-160 REGLO Digital 2 Channel, 230 VAC, 50 Hz		
PC2 73-3299	MS-2/12-160 REGLO Digital 2 Channel, 230 VAC, 50 Hz	**PC2 73-3054**	Replacement MS/CA Click 'n' Go Cassette
PC2 73-2950	MS-4/6-100 REGLO Digital 4 Channel, 115 VAC, 60 Hz	**PC2 73-3055**	MS/CA Pressure Lever Cassette
PC2 73-2915	MS-4/8-100 REGLO Digital 4 Channel, 115 VAC, 60 Hz	**PC2 73-3050**	Foot Switch for Reglo Digital Pumps

REGLO Analog and Digital Peristaltic Pumps

REGLO Analog and Digital Pumps using 3-Stop Collared Tubing Flow Rates

		REGLO Digital 2 Channel						REGLO Digital 4 Channel					
	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	0.6	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	0.061	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	3.1	0.68	68	0.57	57	0.38	38	0.43	43	0.35	35	0.24	24

***Note: Flow rate for REGLO Analog= 2% of Max Flow Rate**

Note: Approximate values: determined with water at 22°C, no differential pressure, with Tygon® Tubing.

Ecoline Microprocessor Controlled Tubing Pumps

VC-280, VC-380, VC-360 & VC-Easy-Load

PC2 72-6426

KEY FEATURES

- Economical and powerful
- Stackable pumps for dosing and filling applications requiring variable flow rates
- Robust stainless steel housing for long life
- Convex rollers treat the liquid and tubing gently
- Reproducible fluid transfer in laboratories and industry
- Analog interface
- Suitable pump for SCP controller, part of the universal servo control perfusion system

APPLICATIONS

- Re-circulating pump for coolant thermostat baths

VC-280 and VC-380

Both 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 WT tubing. One pump is supplied with the 2 roller rotor and the other is supplied with the 3 roller rotor. 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.*

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

			Min. and Max. Flow Rates with Pump (ml/min)							
			VC-280		VC-380		VC-360		VC-EASY-LOAD	
ORDER #	IDMM	WTMM	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
PC2 73-1806	0.8	1.6	-	-	-	-	0.25	25	0.23	23
PC2 73-1807	1.6	1.6	1.7	170	1.6	160	0.9	90	0.86	86
PC2 73-1808	3.2	1.6	6.6	660	5.9	590	3.5	350	3.2	320
PC2 73-1809	4.8	1.6	5.1	1500	13	1300	7.7	770	6.5	650
PC2 73-1810	6.4	1.6	25	2500	23	2300	13	1300	11	1060
PC2 73-1811	8.0	1.6	37	3700	34	3400	-	-	16	1600
PC2 73-1814	9.5	1.6	48	4800	44	4400	-	-	-	-
PC2 73-1815	11.1	1.6	54	5400	50	5000	-	-	-	-

VC-280, VC-380, VC-360 and VC-Easy-Load Specifications

FLOW RATES:	
VC-280	1.7 to 5400 ml/min
VC-380	1.6 to 5000 ml/min
VC-360	0.25 to 1300 ml/min
VC-EASY-LOAD	0.23 to 1600 ml/min
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

Ecoline Microprocessor Controlled Tubing Pumps

ORDER #	PRODUCT	# ROLLERS	FLOW RATE RANGE	DIMENSIONS, H x W x D	WEIGHT	VOLTAGE
PC2 72-6426	Ecoline VC-280	2	1.7-5,400 ml/min	138 x 169 x 256 mm (5.4 x 6.7 x 10.1 in)	5.2 kg (11.5 lbs)	230 VAC, 50 Hz
PC2 72-6427	Ecoline VC-280	2	1.7-5,400 ml/min	138 x 169 x 256 mm (5.4 x 6.7 x 10.1 in)	5.2 kg (11.5 lbs)	115 VAC, 60 Hz
PC2 72-6428	Ecoline VC-380	3	1.6-5,000 ml/min	138 x 169 x 256 mm (5.4 x 6.7 x 10.1 in)	5.3 kg (11.7 lbs)	230 VAC, 50 Hz
PC2 72-6429	Ecoline VC-380	3	1.6-5,000 ml/min	138 x 169 x 256 mm (5.4 x 6.7 x 10.1 in)	5.3 kg (11.7 lbs)	115 VAC, 60 Hz
PC2 72-6430	Ecoline VC-360	3	0.25-1,300 ml/min	138 x 169 x 238 mm (5.4 x 6.7 x 9.41 in)	4.8 kg (10.6 lbs)	230 VAC, 50 Hz
PC2 72-6431	Ecoline VC-360	3	0.25-1,300 ml/min	138 x 169 x 238 mm (5.4 x 6.7 x 9.4 in)	4.8 kg (10.6 lbs)	115 VAC, 60 Hz
PC2 72-6436	Ecoline VC-Easy-Load	3	0.23-1,600 ml/min	138 x 169 x 285 mm (5.4 x 6.7 x 11.2 in)	5.2 kg (11.5 lbs)	230 VAC, 50 Hz
PC2 72-6437	Ecoline VC-Easy-Load	3	0.23-1,600 ml/min	138 x 169 x 285 mm (5.4 x 6.7 x 11.2 in)	5.2 kg (11.5 lbs)	115 VAC, 60 Hz
PC2 72-6439	Repl. Rotor for VC-280	2	-	-	-	-
PC2 72-6440	Repl. Rotor for VC-380	3	-	-	-	-
PC2 72-6438	Drive for VC-Easy Load	-	-	-	-	-

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

PC2 72-6434

PC2 72-6432

KEY FEATURES

- Economical and powerful
- Stackable pumps for dosing and filling applications requiring variable flow rates
- MS/CA click 'n' go cassettes included
- Uses 3-stop collared tubing, see page 82
- Differential pressure 1.0 bar
- Analog interface
- Robust stainless steel housing
- Suitable pump for SCP controller, part of the universal servo control perfusion system

APPLICATIONS

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

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 72 and REGLO Analog/Digital pump lines, see pages 67 and 68, 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 range of flow rates 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 (included). 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**

Ecoline VC-MS/CA8-6 and VC-MS/CA4-12 Flow Rates

		VC-MS/CA 8-6		VC-MS/CA4-12	
AME #	ID MM	MIN.	MAX.	MIN.	MAX.
0	0.13	0.005	0.49	0.003	0.32
02	0.25	0.017	1.7	0.013	1.3
05	0.51	0.067	6.7	0.055	5.5
08	0.76	0.15	15	0.12	12
11	1.02	0.26	26	0.20	20
14	1.22	0.36	36	0.26	26
17	1.52	0.53	53	0.36	36
20	1.85	0.73	73	0.47	47
23	2.54	1.2	120	0.68	68
25	3.17	1.5	150	0.83	83

Note: Approx. values: determined with water at 22°C, no differential pressure, with Tygon® Tubing

Ecoline 4- and 8-Channel 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 (5.4 x 6.6 x 11.4 in)
Ecoline 8-Channel	138 x 169 x 313 mm (5.4 x 6.6 x 12.3 in)
WEIGHT:	
Ecoline 4-Channel	5.4 kg (11.9 lbs)
Ecoline 8-Channel	5.5 kg (12.1 lbs)

Order #	Product
PC2 72-6434	Ecoline Roller Pump VC-MS/CA4-12, 4-Channels, 230 VAC, 50 Hz
PC2 72-6435	Ecoline Roller Pump VC-MS/CA4-12, 4-Channels, 115 VAC, 60 Hz
PC2 72-6432	Ecoline Roller Pump VC-MS/CA8-6, 8-Channels, 230 VAC, 50 Hz
PC2 72-6433	Ecoline Roller Pump VC-MS/CA8-6, 8-Channels, 115 VAC, 60 Hz
PC2 73-3054	Replacement MS/CA , Click 'n' Go, Cassette
PC2 73-3055	Replacement MS/CA, Pressure Lever, Cassette
PC2 73-3051	Foot Switch for Ecoline Pump
PC2 72-6438	Drive for VC-MS/CA4-12 and VC-MS/CA8-6 (without Pump-Head)

Microprocessor Controlled Pumps with or without Dispensing

PC2 73-3132

Figure A

KEY FEATURES

- 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
- Flow rate and dispensing volume (dispensing models only) can be calibrated
- CA click 'n' go cassettes provide defined and repeatable occlusion conditions
- Cassettes are included
- RS-232 interface for PC control – dispensing models only

APPLICATIONS

- Perfusion of animal tissue slices
- Toxicological in-vitro use
- Flow injection analyzers
- Low-flow, multi-channel fluid transfer and dosing or filling applications

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.

Microprocessor Controlled Pumps 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 (PER CHANNEL):	
IPC With Dispensing	0.0004 to 11 ml/min
IP Without Dispensing	0.002 to 44 ml/min
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	1-100%, resolution 0.1% (rpm) or in µl/min or ml/min (flow rate)
IP Without Dispensing	1-100%, resolution 0.1% rpm, resolution 0.1 rpm, resolution 0.03 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 Flow Rates

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
02	0.25	0.005	0.41	0.001	0.10
05	0.51	0.015	1.5	0.004	0.38
08	0.76	0.032	3.2	0.009	0.81
11	1.02	0.057	5.7	0.014	1.4
14	1.22	0.079	7.9	0.020	2.0
17	1.52	0.12	12	0.030	3.0
20	1.85	0.17	17	0.043	4.3
23	2.54	0.30	30	0.075	7.5
25	3.17	0.44	44	0.11	11

**Note: Approximate values: determined with water at 22°C, no differential pressure, with Tygon® Tubing*

Microprocessor Controlled Pumps with or without Dispensing (continued)

Microprocessor Controlled Tubing Pumps					
Order #	**# Channels**	**Flow Rate Range**	**Dimensions H x W x D**	**Weight**	**Power**
IPC Pumps With Dispensing Channels					
PC2 73-3129	4	0.002 to 44 ml/min	130 x 175 x 180 mm (5.1 x 6.9 x 7.1 in)	4.6 kg (10.1 lbs)	230 VAC, 50 Hz
PC2 73-3130	4	0.002 to 44 ml/min	130 x 175 x 180 mm (5.1 x 6.9 x 7.1 in)	4.6 kg (10.1 lbs)	115 VAC, 60 Hz
PC2 73-3131	8	0.002 to 44 ml/min	130 x 175 x 220 mm (5.1 x 6.9 x 7.1 in)	5.1 kg (11.2 lbs)	230 VAC, 50 Hz
PC2 73-3132	8	0.002 to 44 ml/min	130 x 175 x 220 mm (5.1 x 6.9 x 7.1 in)	5.1 kg (11.2 lbs)	115 VAC, 60 Hz
PC2 73-3133	12	0.002 to 44 ml/min	130 x 175 x 260 mm (5.1 x 6.9 x 7.1 in)	5.8 kg (12.8 lbs)	230 VAC, 50 Hz
PC2 73-3134	12	0.002 to 44 ml/min	130 x 175 x 260 mm (5.1 x 6.9 x 7.1 in)	5.8 kg (12.8 lbs)	115 VAC, 60 Hz
PC2 73-2450	16	0.002 to 44 ml/min	130 x 175 x 300 mm (5.1 x 6.9 x 7.1 in)	6.5 kg (14.3 lbs)	230 VAC, 50 Hz
PC2 73-3135	16	0.002 to 44 ml/min	130 x 175 x 300 mm (5.1 x 6.9 x 7.1 in)	6.5 kg (14.3 lbs)	115 VAC, 60 Hz
PC2 73-3136	24	0.002 to 44 ml/min	130 x 175 x 380 mm (5.1 x 6.9 x 7.1 in)	7.9 kg (17.4 lbs)	230 VAC, 50 Hz
PC2 73-3137	24	0.002 to 44 ml/min	130 x 175 x 380 mm (5.1 x 6.9 x 7.1 in)	7.9 kg (17.4 lbs)	115 VAC, 60 Hz
IPC-N Pumps With Dispensing Channels					
PC2 73-3138	4	0.0004 to 11 ml/min	130 x 175 x 180 mm (5.1 x 6.9 x 7.1 in)	4.6 kg (10.1 lbs)	230 VAC, 50 Hz
PC2 73-3139	4	0.0004 to 11 ml/min	130 x 175 x 180 mm (5.1 x 6.9 x 7.1 in)	4.6 kg (10.1 lbs)	115 VAC, 60 Hz
PC2 73-3140	8	0.0004 to 11 ml/min	130 x 175 x 220 mm (5.1 x 6.9 x 8.7 in)	5.1 kg (11.2 lbs)	230 VAC, 50 Hz
PC2 73-3141	8	0.0004 to 11 ml/min	130 x 175 x 220 mm (5.1 x 6.9 x 8.7 in)	5.1 kg (11.2 lbs)	115 VAC, 60 Hz
PC2 73-2421	12	0.0004 to 11 ml/min	130 x 175 x 260 mm (5.1 x 6.9 x 10.2 in)	5.8 kg (12.8 lbs)	230 VAC, 50 Hz
PC2 73-3142	12	0.0004 to 11 ml/min	130 x 175 x 260 mm (5.1 x 6.9 x 10.2 in)	5.8 kg (12.8 lbs)	115 VAC, 60 Hz
PC2 73-3143	16	0.0004 to 11 ml/min	130 x 175 x 300 mm (5.1 x 6.9 x 11.8 in)	6.5 kg (14.3 lbs)	230 VAC, 50 Hz
PC2 73-3144	16	0.0004 to 11 ml/min	130 x 175 x 300 mm (5.1 x 6.9 x 11.8 in)	6.5 kg (14.3 lbs)	115 VAC, 60 Hz
PC2 73-3145	24	0.0004 to 11 ml/min	130 x 175 x 380 mm (5.1 x 6.9 x 15 in)	7.9 kg (17.4 lbs)	230 VAC, 50 Hz
PC2 73-3146	24	0.0004 to 11 ml/min	130 x 175 x 380 mm (5.1 x 6.9 x 15 in)	7.9 kg (17.4 lbs)	115 VAC, 60 Hz
IP Pumps Without Dispensing Channels					
PC2 73-3147	4	0.002 to 44 ml/min	130 x 175 x 180 mm (5.1 x 6.9 x 7.1 in)	4.6 kg (10.1 lbs)	230 VAC, 50 Hz
PC2 73-3148	4	0.002 to 44 ml/min	130 x 175 x 180 mm (5.1 x 6.9 x 7.1 in)	4.6 kg (10.1 lbs)	115 VAC, 60 Hz
PC2 73-3149	8	0.002 to 44 ml/min	130 x 175 x 220 mm (5.1 x 6.9 x 8.7 in)	5.1 kg (11.2 lbs)	230 VAC, 50 Hz
PC2 73-3150	8	0.002 to 44 ml/min	130 x 175 x 220 mm (5.1 x 6.9 x 8.7 in)	5.1 kg (11.2 lbs)	115 VAC, 60 Hz
PC2 73-3151	12	0.002 to 44 ml/min	130 x 175 x 260 mm (5.1 x 6.9 x 10.2 in)	5.8 kg (12.8 lbs)	230 VAC, 50 Hz
PC2 73-3152	12	0.002 to 44 ml/min	130 x 175 x 260 mm (5.1 x 6.9 x 10.2 in)	5.8 kg (12.8 lbs)	115 VAC, 60 Hz
PC2 73-3153	16	0.002 to 44 ml/min	130 x 175 x 300 mm (5.1 x 6.9 x 11.8 in)	6.5 kg (14.3 lbs)	230 VAC, 50 Hz
PC2 73-3154	16	0.002 to 44 ml/min	130 x 175 x 300 mm (5.1 x 6.9 x 11.8 in)	6.5 kg (14.3 lbs)	115 VAC, 60 Hz
PC2 73-3155	24	0.002 to 44 ml/min	130 x 175 x 380 mm (5.1 x 6.9 x 15 in)	7.9 kg (17.4 lbs)	230 VAC, 50 Hz
PC2 73-3156	24	0.002 to 44 ml/min	130 x 175 x 380 mm (5.1 x 6.9 x 15 in)	7.9 kg (17.4 lbs)	115 VAC, 60 Hz
IP-N Pumps Without Dispensing Channels					
PC2 73-3157	4	0.0004 to 11 ml/min	130 x 175 x 180 mm (5.1 x 6.9 x 7.1 in)	4.6 kg (10.1 lbs)	230 VAC, 50 Hz
PC2 73-3158	4	0.0004 to 11 ml/min	130 x 175 x 180 mm (5.1 x 6.9 x 7.1 in)	4.6 kg (10.1 lbs)	115 VAC, 60 Hz
PC2 73-3159	8	0.0004 to 11 ml/min	130 x 175 x 220 mm (5.1 x 6.9 x 8.7 in)	5.1 k (11.2 lbs)	230 VAC, 50 Hz
PC2 73-3160	8	0.0004 to 11 ml/min	130 x 175 x 220 mm (5.1 x 6.9 x 8.7 in)	5.1 kg (11.2 lbs)	115 VAC, 60 Hz
PC2 73-3161	12	0.0004 to 11 ml/min	130 x 175 x 260 mm (5.1 x 6.9 x 10.2 in)	5.8 kg (12.8 lbs)	230 VAC, 50 Hz
PC2 73-3162	12	0.0004 to 11 ml/min	130 x 175 x 260 mm (5.1 x 6.9 x 10.2 in)	5.8 kg (12.8 lbs)	115 VAC, 60 Hz
PC2 73-3163	16	0.0004 to 11 ml/min	130 x 175 x 300 mm (5.1 x 6.9 x 11.8 in)	6.5 kg (14.3 lbs)	230 VAC, 50 Hz
PC2 73-3164	16	0.0004 to 11 ml/min	130 x 175 x 300 mm (5.1 x 6.9 x 11.8 in)	6.5 kg (14.3 lbs)	115 VAC, 60 Hz
PC2 73-3165	24	0.0004 to 11 ml/min	130 x 175 x 380 mm (5.1 x 6.9 x 15 in)	7.9 kg (17.4 lbs)	230 VAC, 50 Hz
PC2 73-3166	24	0.0004 to 11 ml/min	130 x 175 x 380 mm (5.1 x 6.9 x 15 in)	7.9 kg (17.4 lbs)	115 VAC, 60 Hz

MCP Pump Drive

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

KEY FEATURES

- Stores 4 programs in memory
- 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

APPLICATIONS

- Filling of bottles and test tubes
- Dispensing of pre-defined volumes

This programmable pump drive offers various dispensing modes, providing highly reproducible and accurate results. Pump head must be purchased separately. A wide selection of pump heads with single or multi-channel capabilities are available for the MCP pump drive. See pages 76 to 80.

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.

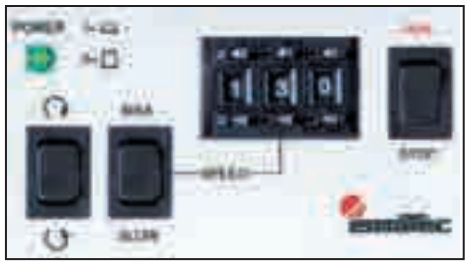
Calibration: Dispensing Volume/Flow Rate

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.

MCP Pump Drive Specifications	
MODEL	MCP pump drive only, pump head must be purchased separately
SPEED	1 to 240 rpm with 0.1 rpm resolution
BACK PRESSURE	1.5 bar maximum (22 PSI)
MAINS CONNECTION	115 VAC (50/60 Hz) or 230 VAC (50/60 Hz)
POWER CONSUMPTION	100 W maximum
RS-232 INTERFACE 8 PUMPS	Baud rate 9600 or 1200 baud, 8 bit, 1 stop bit, no parity for complete computer control 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)

Order #	Product
PC2 73-3026	MCP Pump Drive, 230 VAC, 50/60 Hz
PC2 73-3029	MCP Pump Drive, 115 VAC, 50/60 Hz
PC2 73-3048	Foot Switch for MCP Pump Drive

BVP Pump Drive



KEY FEATURES

- Smooth operation at a low noise level
- Robust drive for long-term operations
- Small footprint, 2 drives are stackable
- 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. It is equipped with a 3 digit potentiometer speed selector and an analog interface.

Pump Head must be purchased separately. A wide selection of pump heads with single or multi-channel capabilities are available for the BVP pump drive. See pages 76 to 80. 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.

BVP Pump Drive Specifications	
MODEL	BVP pump drive only, pump head must be purchased separately
SPEED	2.4 to 240 rpm, adjustable in 0.1 % steps
BACK PRESSURE	1.5 bar maximum (22 PSI)
MAINS CONNECTION	115 VAC (50/60 Hz) or 230 VAC (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)

Order #	Product
PC2 73-3028*	BVP Pump Drive, 230 VAC, 50/60 Hz
PC2 73-3027*	BVP Pump Drive, 115 VAC, 50/60 Hz
PC2 73-3049	Foot Switch for BVP Pump Drive
Single Channel Pump Head, see pages 76 and 77	
PC2 73-3035	380AD
PC2 73-3119	PRO-280
PC2 73-3120	PRO-380
PC2 73-3121	PRO-281
PC2 73-3122	PRO-381
Multi-Channel Pump Head, see pages 79 to 81	
PC2 73-3031	CA-4
PC2 73-3036	CA-8
PC2 73-3037	CA-12
PC2 73-3040	SB (Requires Tube Bed Set)
PC2 73-3030	MS3
PC2 73-3038	MS/CA4-12
PC2 73-3033	MS/CA8-6

** Pump head must be purchased separately.*

Gentle Pumping Pump Heads

PC2 73-3119

PC2 73-3120

KEY FEATURES

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

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 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.

Gentle Pumping Pump Heads Specifications

PUMP HEAD	PRO-280	PRO-380	PRO-281	PRO-381
NUMBER OF CHANNELS	1	1	1	1
NUMBER OF ROLLERS	2	3	2	3
TUBING WALL THICKNESS	1.6 mm	1.6 mm	2.4 mm	2.4 mm
FLOW RATE RANGE ML/MIN	0.49 - 3,700	0.45 - 3,400	3.6 - 3,100	3.3 - 2,900

Gentle Pumping Pump Heads Flow Rates

Standard Tygon® R-3603/R-3607

		PRO-280 FLOW RATE, ML/MIN FLOW RATE, ML/MIN		PRO-380 FLOW RATE, ML/MIN FLOW RATE, ML/MIN	
Tubing ID mm	Wall mm	Min.	Max.	Min.	Max.
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	1,000	3.7	890
6.4	1.6	7.2	1,700	6.5	1,600
9.5	1.6	14	3,300	13	3,000
11.1	1.6	16	3,700	14	3,400

Standard Tygon® R-3603/R-3607

		PRO-281 FLOW RATE, ML/MIN FLOW RATE, ML/MIN		PRO-381 FLOW RATE, ML/MIN FLOW RATE, ML/MIN	
Tubing ID mm	Wall mm	Min.	Max.	Min.	Max.
4.8	2.4	3.6	870	3.3	800
6.4	2.4	6.5	1,600	5.8	1,400
8	2.4	9.9	2,400	8.8	2,100
9.5	2.4	13	3,100	12	2,900

**Note: Approximate values: determined with water at 22°C, no differential pressure, with Tygon® Tubing*

Order #	Product
PC2 73-3119	PRO-280 Gentle Pumping Head
PC2 73-3120	PRO-380 Gentle Pumping Head
PC2 73-3121	PRO-281 Gentle Pumping Head
PC2 73-3122	PRO-381 Gentle Pumping Head

Pump Head 380AD

Single-Channel
Pump Head 380AD

KEY FEATURES

- 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.

Adjustable roller pressure accommodates 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.

380AD Pump Head 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

380AD Pump Head Using Standard Tubing Flow Rates

		FLOW RATES, ML/MIN	
Tubing ID	**Wall Thickness**	**Minimum**	**Maximum**
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	1,500
8.0 mm	1.6 mm	9.5	2,300
9.5 mm	1.6 mm	13	3,000
11.1 mm	1.6 mm	15	3,600
4.8 mm	2.4 mm	3.4	830
6.4 mm	2.4 mm	6.2	1,500

**Note: Approximate values: determined with water at 22°C, no differential pressure, with Tygon® Tubing*

Order #	Product
PC2 73-3026	380AD Single-Channel Pump Head for MCP/BVP Pump Drives

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

SB Pump Head with 2V Tube Bed Set

SB Pump Head with 3V Tube Bed Set

KEY FEATURES

- Ideal for sensitive substances requiring a smooth pressure adjustment
- Uses spring-loaded tube bed set – choice of 1, 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)

SB Pump Head Specifications

SB Pump Head with 2V Tube Bed Set	
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	
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

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

	2V TUBE BED SET, ML/MIN		3V TUBE BED SET, ML/MIN	
Standard Tubing ID mm	**min**	**max**	**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

**Note: Approximate values: determined with water at 22°C, no differential pressure, with Tygon® Tubing*

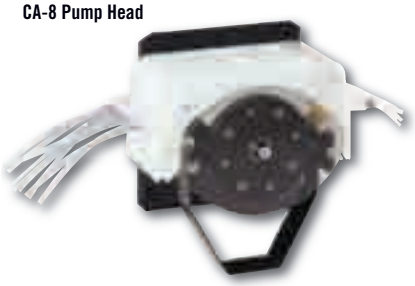
Order #	Product
PC2 73-3040	SB Pump Head for BVP/MCP Pump Drives*
PC2 73-3045	2V Tube Bed Set for SB Pump Head
PC2 73-3046	3V Tube Bed Set for SB Pump Head

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

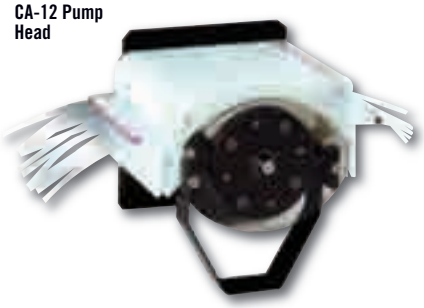
CA Pump Heads

PC2 73-3031
CA-4 Pump Head

PC2 73-3036
CA-8 Pump Head



PC2 73-3037
CA-12 Pump Head



KEY FEATURES

- For use with MCP and BVP Pump Drive, see pages 74 and 75
- CA Click 'n' Go 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
- Uses 2-stop collared tubing 0.13 to 3.17 mm ID, see page 83
- 0.002 to 230 ml/min flow rate range

The CA pump heads for the MCP/BVP pump drives, see pages 74 and 75, 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 80. The MS/CA 4-12 and 8-6 multi-channel pump head series offer 8 rollers, and stackable head assemblies that allow you to increase the number of tubing channels per pump drive.

CA Pump Drive 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

CA Pump Heads Flow Rate Range

2-Stop Collared Tubing

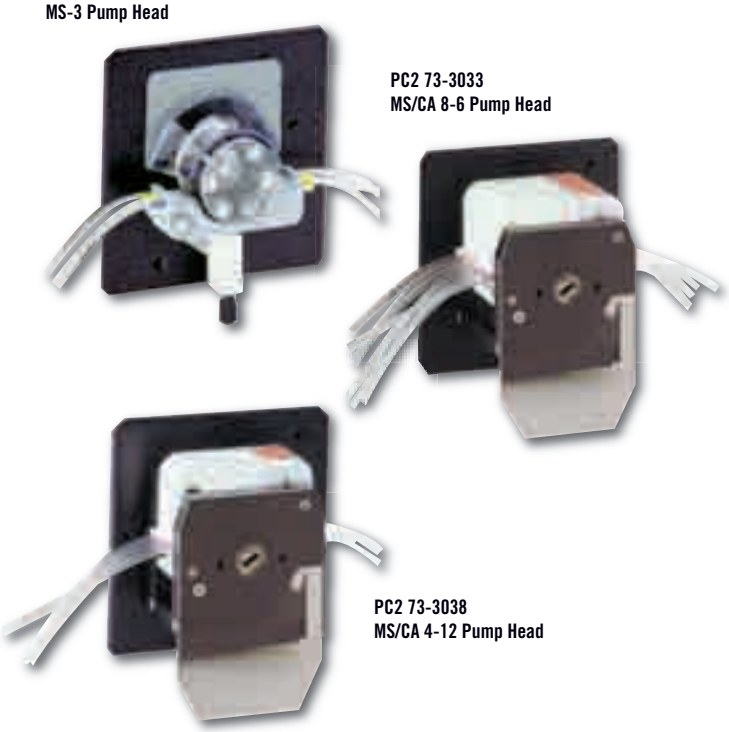
		ML/MIN PER CHANNEL	
ENE#	Tubing ID mm	Minimum	Maximum
00	0.13	0.002	0.31
01	0.19	0.004	0.94
02	0.25	0.008	1.8
03	0.38	0.019	4.5
04	0.44	0.025	6.1
05	0.51	0.034	8.2
06	0.57	0.042	10
07	0.64	0.053	13
08	0.76	0.074	18
09	0.89	0.1	24
10	0.95	0.11	27
11	1.02	0.13	31
12	1.09	0.14	35
13	1.14	0.16	38
14	1.22	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.

Order #	Product
PC2 73-3035	CA-4 Pump Head 4 Channel for BVP/MCP Pump Drives
PC2 73-3036	CA-8 Pump Head 8 Channel for BVP/MCP Pump Drives
PC2 73-3037	CA-12 Pump Head 12 Channel for BVP/MCP Pump Drives
PC2 73-3052	Replacement CA Cassette, Click 'n' Go

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

PC2 73-3030
MS-3 Pump Head



PC2 73-3033
MS/CA 8-6 Pump Head

PC2 73-3038
MS/CA 4-12 Pump Head

MS-3 PUMP HEAD

- 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
- 0.002 to 100 ml/min flow rates
- Uses 3-stop collared tubing, 0.13 to 3.17 mm ID, see page 82
- Back pressure has max of 1.5 bar (22 PSI)

MS/CA 4-12 PUMP HEAD

- MS/CA Click 'n' Go Cassettes are included
- 12 Rollers for extremely low pulsation
- 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 82
- Back pressure has maximum of 1.0 bar (14.5 PSI)

MS/CA 8-6 PUMP HEAD

- MS/CA Click 'n' Go Cassettes are included
- 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 82
- Back pressure has maximum of 1.0 bar (14.5 PSI)

MS and MS/CA Cassettes Flow Rate Range

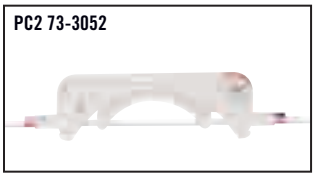
	MS-3 3 Channels PC2 73-3030 Flow Rates ml/min per Channel		MS/CA 4-12 4, 8, 12 or 16 Channels PC2 73-3038 Flow Rates ml/min per Channel		MS/CA 8-6 8, 16, or 24 Channels PC2 73-3033 Flow Rates ml/min per Channel	
3-Stop Collared Tubing ID mm	Min.	Max.	Min.	Max.	Min.	Max.
0.13	0.002	0.4	0.001	0.22	0.002	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	0.042	10
0.89	0.053	13	0.044	11	0.057	14
0.95	0.06	14	0.050	12	0.064	15
1.02	0.69	17	0.056	13	0.073	18
1.09	0.078	19	0.063	15	0.083	20
1.14	0.084	20	0.067	16	0.090	22
1.22	0.10	23	0.075	18	0.10	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	0.10	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: Approximate values: determined with water at 22°C, no differential pressure, with Tygon® Tubing*

Order #	Product
PC2 73-3030	MS-3 Pump Head for BVP/MCP Pump Drives
PC2 73-3038	MS/CA 4-12 Pump Head for BVP/MCP Pump Drives
PC2 73-3046	3V Tube Bed Set for SB Pump Head
PC2 73-3039	MS/CA 4-12 Extension Block, 4 Channel
PC2 73-3033	MS/CA 8-6 Pump Head for BVP/MCP Pump Drives
PC2 73-3034	MS/CA 8-6 Extension Block, 8 Channel

Tubing Cassettes and Accessories

Click 'n' Go Cassettes



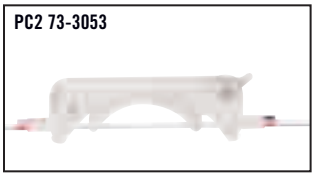
Supplied standard with all ISMATEC cassette pumps, these innovative tubing cassettes offer the following advantages:

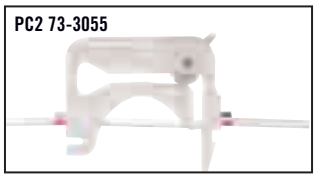
- **Automatic pressure mechanism to set tubing pressure**
- **Calibrated, fatigue-free spring guarantees optimal, reproducible tubing pressure independent of diameter, material and state of tubing**
- **Long term channel-to-channel conformity**

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.

Order #	Product
PC2 73-3054	MS/CA Cassette, Click 'n' Go
PC2 73-3052	CA Cassette, Click 'n' Go
PC2 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 allows 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**

Order #	Product
PC2 73-3055	MS/CA Cassette, Pressure Lever
PC2 73-3053	CA Cassette, Click 'n' Go
PC2 73-3303	Spare POM-C Adaptor for CA Cassettes

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.

Order #	Product
PC2 73-3048	Foot Switch for MCP IP, IPC, IP-N, IPC-N
PC2 73-3049	Foot Switch for BVP and REGLO Analog Pumps
PC2 73-3050	Foot Switch for REGLO Digital Pumps
PC2 73-3051	Foot Switch for Ecoline Pumps

Rotors for Ecoline VC-280 and VC-380 Pumps, see page 70

Order #	Product
PC2 73-3114	Rotor, 3 Rollers, Black, Accepts 2.4 mm Tubing Wall Thickness
PC2 73-3115	Rotor, 2 Rollers, Black, Accepts 2.4 mm Tubing Wall Thickness
PC2 73-3116	Rotor, 2 Rollers, Red, Accepts 1.6 mm Tubing Wall Thickness
PC2 73-3117	Rotor, 3 Rollers, Red, Accepts 1.6 mm Tubing Wall Thickness

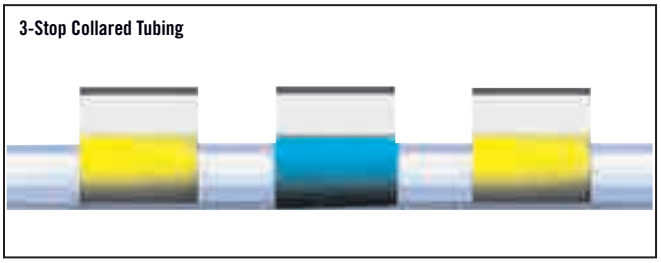
Pump Accessories

PUMP MODEL	FOOTSWITCH #	CASSETTE TYPE*	ORDER #
REGLO Digital	**PC2 73-3050**	MS/CA CNG	**PC2 73-3054**
REGLO Analog	**PC2 73-3049**	MS/CA CNG	**PC2 73-3054**
Ecoline VC-MS/CA8-6	**PC2 73-3051**	MS/CA CNG	**PC2 73-3054**
Ecoline VC-MS/CA4-12	**PC2 73-3051**	MS/CA CNG	**PC2 73-3054**
Ecoline VC-280, VC-380	**PC2 73-3051**	Exchangeable Rotors	
Ecoline VC-360	**PC2 73-3051**	N/A	–
IP, IP-N	**PC2 73-3048**	CA CNG	**PC2 73-3052**
IPC, IPC-N	**PC2 73-3048**	CA CNG	**PC2 73-3052**
MCP	**PC2 73-3048**	Depends on pump head	
BVP	**PC2 73-3049**	Depends on pump head	

**CNG = Click 'n' Go*

Pump Tubing

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



This 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 is required for the following:

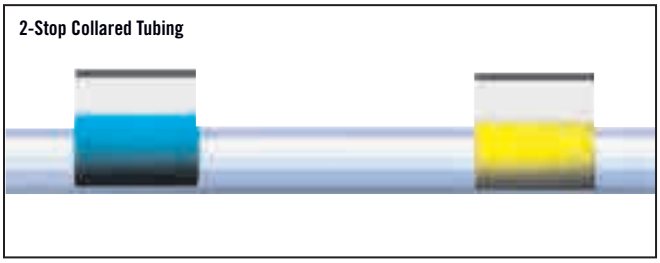
- **Pumps**
  - **Ecoline VC-MS/CA4-12 and VC-MS/CA8-6, see page 71**
  - **All REGLO Digital, see page 65**
  - **All REGLO Analog, see page 67**
- **Pump Heads**
  - **MS-3, see page 80**
  - **MS/CA 4-12, see page 80**
  - **MS/CA 8-6, see page 80**

3-Stop Collared Pump Tubing

			Tygon® ST R-3607	Tygon® LFL	Tygon® SI Silicone 3350	PharMed® Ismaprene
AME #	TUBING ID	Color Code	ORDER #	ORDER #	ORDER #	ORDER #
00	0.13 mm	orange-black	PC2 73-1816	–	–	–
01	0.19 mm	orange-red	PC2 73-1817	–	–	–
02	0.25 mm	orange-blue	PC2 73-1818	PC2 73-3214	–	PC2 73-3175
03	0.38 mm	orange-green	PC2 73-1819	PC2 73-3215	–	PC2 73-3176
04	0.44 mm	green-yellow	PC2 73-1820	–	–	–
05	0.51 mm	orange-yellow	PC2 73-1821	PC2 73-3216	PC2 73-3262	PC2 73-3177
06	0.57 mm	white-yellow	PC2 73-1822	–	–	–
07	0.64 mm	orange-white	PC2 73-1823	PC2 73-3217	PC2 73-3263	PC2 73-3178
08	0.76 mm	black-black	PC2 73-1824	PC2 73-3218	PC2 73-3264	PC2 73-3179
09	0.89 mm	orange-orange	PC2 73-1825	PC2 73-3219	PC2 73-3265	PC2 73-3180
10	0.95 mm	white-black	PC2 73-1826	–	–	–
11	1.02 mm	white-white	PC2 73-1827	PC2 73-3220	PC2 73-3266	PC2 73-3181
12	1.09 mm	white-red	PC2 73-1828	–	–	–
13	1.14 mm	red-red	PC2 73-1829	PC2 73-3221	PC2 73-3267	PC2 73-3182
14	1.22 mm	red-grey	PC2 73-0126	–	–	–
15	1.3 mm	grey-grey	PC2 73-1830	PC2 73-3222	PC2 73-3268	PC2 73-3183
16	1.42 mm	yellow-yellow	PC2 73-1831	PC2 73-3223	PC2 73-3269	PC2 73-3184
17	1.52 mm	yellow-blue	PC2 73-1832	PC2 73-3224	PC2 73-3270	PC2 73-3185
18	1.65 mm	blue-blue	PC2 73-1833	PC2 73-3225	PC2 73-3271	PC2 73-3186
19	1.75 mm	blue-green	PC2 73-1834	–	–	–
20	1.85 mm	green-green	PC2 73-1835	PC2 73-3226	PC2 73-3272	PC2 73-3187
21	2.06 mm	purple-purple	PC2 73-1836	PC2 73-3227	PC2 73-3273	PC2 73-3188
22	2.29 mm	purple-black	PC2 73-1837	PC2 73-3228	PC2 73-3274	PC2 73-3189
23	2.54 mm	purple-orange	PC2 73-1838	PC2 73-3229	PC2 73-3275	PC2 73-3190
24	2.79 mm	purple-white	PC2 73-0155	PC2 73-3230	PC2 73-3276	PC2 73-3191
25	3.17 mm	black-white	PC2 73-1839	–	–	–
Pack Size			12 pieces	12 pieces	6 pieces	6 pieces

Pump Tubing

2-Stop Tygon® Pump Tubing for CA Cassettes & Harvard Peristaltic Pump



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 is required for the following:

- NEW Harvard Peristaltic Pump P-230, see page 62
- Pumps
  - IP, IPC, IP-N, IPC-N, see page 72
- Pump Heads
  - CA-4, see page 79
  - CA-8, see page 79
  - CA-12, see page 79

2-Stop Collared Pump Tubing

			Tygon® R-3607	Tygon® LFL	ST Tygon® SI Silicone 3350	Ismaprene
ENE #	Tubing ID	Color Code	ORDER #	ORDER #	ORDER #	ORDER #
00	0.13 mm	orange-black	PC2 73-3174	–	–	–
01	0.19 mm	orange-red	PC2 73-1840	–	–	–
02	0.25 mm	orange-blue	PC2 73-1841	PC2 73-3231	–	PC2 73-3192
03	0.38 mm	orange-green	PC2 73-1842	PC2 73-3232	–	PC2 73-3193
04	0.44 mm	green-yellow	PC2 73-1843	–	–	–
05	0.51 mm	orange-yellow	PC2 73-1844	PC2 73-3233	PC2 73-3277	PC2 73-3194
06	0.57 mm	white-yellow	PC2 73-1845	–	–	–
07	0.64 mm	orange-white	PC2 73-1846	PC2 73-3234	–	PC2 73-3195
08	0.76 mm	black-black	PC2 73-1847	PC2 73-3235	PC2 73-3278	PC2 73-3196
09	0.89mm	orange-orange	PC2 73-1848	PC2 73-3236	PC2 73-3279	PC2 73-3197
10	0.95 mm	white-black	PC2 73-1849	–	–	–
11	1.02 mm	white-white	PC2 73-1850	PC2 73-3237	PC2 73-3280	PC2 73-3198
12	1.09 mm	white-red	PC2 73-1851	–	–	–
13	1.14 mm	red-red	PC2 73-1852	PC2 73-3238	PC2 73-3281	PC2 73-3199
14	1.22 mm	red-grey	PC2 73-1853	–	–	–
15	1.3 mm	grey-grey	PC2 73-1854	PC2 73-3239	PC2 73-3282	PC2 73-3200
16	1.42 mm	yellow-yellow	PC2 73-1855	PC2 73-3240	PC2 73-3283	PC2 73-3201
17	1.52 mm	yellow-blue	PC2 73-1856	PC2 73-3241	PC2 73-3284	PC2 73-3202
18	1.65 mm	blue-blue	PC2 73-1857	PC2 73-3242	PC2 73-3285	PC2 73-3203
19	1.75 mm	blue-green	PC2 73-1858	–	–	–
20	1.85 mm	green-green	PC2 73-1859	PC2 73-3243	PC2 73-3286	PC2 73-3204
21	2.06 mm	purple-purple	PC2 73-1860	PC2 73-3244	PC2 73-3287	PC2 73-3205
22	2.29 mm	purple-black	PC2 73-1861	PC2 73-3245	PC2 73-3288	PC2 73-3206
23	2.54 mm	purple-orange	PC2 73-1862	PC2 73-3246	PC2 73-3289	PC2 73-3207
24	2.79 mm	purple-white	PC2 73-1863	PC2 73-3247	PC2 73-3290	PC2 73-3208
25	3.17 mm	black-white	PC2 73-1864	–	–	–
Pack Size			12 pieces	12 pieces	6 pieces	6 pieces

Pump Tubing

3-Stop Tubing for the NEW Harvard Peristaltic Pump P-70 (see page 62)

Harvard Peristaltic Pumps P-70 3-Stop Tubing

		Max Flow Rate (ml/min)				Connector[2] Size
Tube Bore mm (in)	Color Code	8-Roller	Silicone (pkg. of 6)	Marprene (pkg. of 6)	PVC (pkg. of 6)	Gauge/Barb Size
0.13 mm (0.005 in)	Orange/Black	0.15	–	–	PC2 72-0653	32 g
0.19 mm (0.007 in)	Orange/Red	0.32	–	–	PC2 72-0654	31 g
0.25 mm (0.010 in)	Orange/Blue	0.56	–	PC2 72-0621	PC2 72-0655	28 g
0.38 mm (0.015 in)	Orange/Green	1.30	–	PC2 72-0622	PC2 72-0656	25 g
0.50 mm (0.020 in)	Orange/Yellow	2.25	–	PC2 72-0623	PC2 72-0657	23 g
0.63 mm (0.025 in)	Orange/White	3.57	PC2 72-0638	PC2 72-0624	PC2 72-0658	22 g
0.76 mm (0.030 in)	Black/Black	5.19	PC2 72-0639	PC2 72-0625	PC2 72-0659	20 g
0.88 mm (0.035 in)	Orange/Orange	6.96	PC2 72-0640	PC2 72-0626	PC2 72-0660	19 g
1.02 mm (0.040 in)	White/White	9.36	PC2 72-0641	PC2 72-0627	PC2 72-0661	18 g
1.14 mm (0.045 in)	Red/Red	11.69	PC2 72-0642	PC2 72-0628	PC2 72-0662	1/16 inch
1.29 mm (0.050 in)	Gray/Gray	14.96	PC2 72-0643	PC2 72-0629	PC2 72-0663	1/16 inch
1.42 mm (0.055 in)	Yellow/Yellow	18.13	PC2 72-0644	PC2 72-0630	PC2 72-0664	1/16 inch
1.47 mm (0.058 in)	Translucent	19.43	PC2 72-0645	–	–	1/16 inch
1.52 mm (0.060 in)	Yellow/Blue	20.78	PC2 72-0646	PC2 72-0631	PC2 72-0665	1/16 inch
1.65 mm (0.065 in)	Blue/Blue	24.48	PC2 72-0647	PC2 72-0632	PC2 72-0666	1/16 inch
1.85 mm (0.070 in)	Green/Green	30.78	PC2 72-0648	PC2 72-0633	PC2 72-0667	3/32 inch
2.05 mm (0.080 in)	Purple/Purple	37.79	PC2 72-0649	PC2 72-0634	PC2 72-0668	3/32 inch
2.38 mm (0.095 in)	Purple/Black	50.94	PC2 72-0650	PC2 72-0635	PC2 72-0669	3/32 inch
2.54 mm (0.100 in)	Purple/Orange	58.02	PC2 72-0651	PC2 72-0636	PC2 72-0670	1/8 inch
2.79 mm (0.110 in)	Purple/White	70.00	PC2 72-0652	PC2 72-0637	PC2 72-0671	1/8 inch

[2] Size of hypodermic tubing (g. gauge) or barbed connector (in.) needed. Connection with tubing segment requires hypodermic tubing or barbed connector; see page 103 to 110.

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.

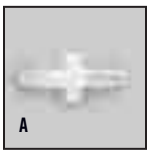
Standard Tubing is required for the following:

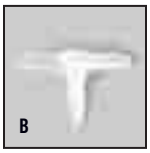
- **Pumps**
  - **For use with NEW Harvard Peristaltic Pump P-1500, see page 62**
  - **Ecoline VC-280, see page 70**
  - **Ecoline VC-380, see page 70**
  - **Ecoline VC-360, see page 70**
  - **Ecoline VC-Easy-Load, see page 70**
- **Pump Heads**
  - **PRO-280, see page 76**
  - **PRO-380, see page 76**
  - **PRO-281, see page 76**
  - **PRO-381, see page 76**
  - **380AD, see page 77**
  - **SB-2V, see page 78**
  - **SB-3V, see page 78**

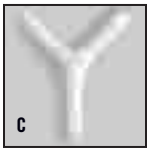
Standard Pump Tubing

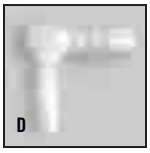
		Tygon® ST R-3603	Tygon® LFL	Tygon® SI Silicone 3350	PharMed® Ismaprene
Tubing ID	Wall Thickness	ORDER #	ORDER #	ORDER #	ORDER #
NEW Harvard Peristaltic Pump P-1500 can only use standard tubing with a wall thickness of 1.6 mm, see page 62.					
0.8 mm	1.6 mm	PC2 73-1806	–	–	PC2 72-0958
1.6 mm	1.6 mm	PC2 72-1016	PC2 72-0983	PC2 73-3255	PC2 72-0960
3.2 mm	1.6 mm	PC2 72-1020	PC2 72-0984	PC2 73-3256	PC2 72-0963
4 mm	1.6 mm	PC2 72-1022	–	–	–
4.8 mm	1.6 mm	PC2 72-1024	PC2 72-0985	PC2 73-3257	PC2 72-0964
6.4 mm	1.6 mm	PC2 72-1026	PC2 72-0986	PC2 73-3259	PC2 72-0965
8 mm	1.6 mm	PC2 72-1027	PC2 72-0988	PC2 73-3261	PC2 72-0967
9.5 mm	1.6 mm	PC2 72-4621	–	–	PC2 72-0968
11.1 mm	1.6 mm	PC2 73-1815	–	PC2 73-3291	–
4.8 mm	2.4 mm	PC2 73-1812	–	PC2 73-3258	–
6.4 mm	2.4 mm	PC2 73-1813	–	PC2 73-3260	–
8 mm	2.4 mm	PC2 73-3249	–	PC2 73-3252	–
9.5 mm	2.4 mm	PC2 72-1029	–	PC2 73-3253	–
11.1 mm	2.4 mm	PC2 72-1031	–	PC2 73-3254	–
Length Supplied		15 m (49 ft)	7.5 m (24.6 ft)	15 m (49 ft)	7.5 m (24.6 ft)

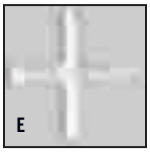
Extension Tubing & Connectors







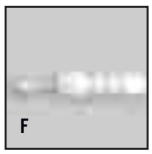


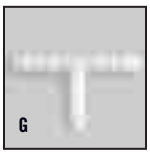


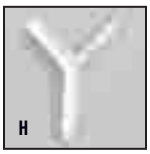
Standard Tube Connectors, Plastic

The Plastic Tube Connectors are designed to assist you in quickly and easily making connections between 2 and 3-Stop Collared Tubing of similar sizes. There are five different connector types available. They are supplied non-sterile in packages of 10.

	Straight Connector (A)	T-Connector (B)	Y-Connector (C)	Angle Connector (D)	Cross Connector (E)
Tube ID	ORDER #	ORDER #	ORDER #	ORDER #	ORDER #
1.5 mm	PC2 72-9262	PC2 72-9275	–	PC2 72-9306	–
2.5 mm	PC2 72-9263	PC2 72-9276	–	PC2 72-9307	–
3.0 mm	PC2 72-9264	PC2 72-9282	PC2 72-9295	PC2 72-9308	–
4.0 mm	PC2 72-9265	PC2 72-9283	PC2 72-9296	PC2 72-9309	PC2 72-9320
5.0 mm	PC2 72-9266	PC2 72-9284	PC2 72-9297	PC2 72-9310	PC2 72-9321
6.0 mm	PC2 72-9267	PC2 72-9285	PC2 72-9298	PC2 72-9311	PC2 72-9322
7.0 mm	–	PC2 72-9286	–	–	–
8.0 mm	PC2 72-9268	PC2 72-9287	PC2 72-9299	PC2 72-9312	–
10.0 mm	PC2 72-9269	PC2 72-9288	PC2 72-9300	PC2 72-9313	–
12.0 mm	PC2 72-9270	PC2 72-9289	PC2 72-9301	PC2 72-9314	–
13.0 mm	PC2 72-9271	PC2 72-9290	PC2 72-9302	PC2 72-9315	–
14.0 mm	PC2 72-9272	PC2 72-9291	PC2 72-9303	PC2 72-9316	–
15.0 mm	–	PC2 72-9292	–	PC2 72-9317	–
16.0 mm	PC2 72-9273	PC2 72-9293	PC2 72-9304	PC2 72-9318	–
19.0 mm	PC2 72-9274	PC2 72-9294	PC2 72-9305	PC2 72-9319	–







Plastic, Reducer Tube Connectors

The Plastic Tube Connectors are designed to assist you in quickly and easily making connections between 2 and 3-Stop Collared Tubing of dissimilar sizes. There are three different connector types available. They are supplied non-sterile in packages of 10.

Straight Connector (F)			T-Connector (G)			Y-Connector (H)		
ORDER #	Tube ID	Tube ID	ORDER #	Tube ID	Tube ID	ORDER #	Tube ID	Tube ID
PC2 72-9323	1.5 mm	2.5 mm	PC2 72-9334	3.0 mm	4.0 mm	PC2 72-9349	4.0 mm	6.0 mm
PC2 72-9324	1.5 mm	3.0 mm	PC2 72-9335	4.0 mm	6.0 mm	PC2 72-9350	6.0 mm	8.0 mm
PC2 72-9325	2.5 mm	3.0 mm	PC2 72-9336	6.0 mm	4.0 mm			
PC2 72-9326	3.0 mm	4.0 mm	PC2 72-9337	8.0 mm	4.0 mm			
PC2 72-9327	4.0 mm	6.0 mm	PC2 72-9338	8.0 mm	6.0 mm			
PC2 72-9328	4.0 mm	8.0 mm	PC2 72-9339	8.0 mm	12.0 mm			
PC2 72-9329	6.0 mm	8.0 mm	PC2 72-9340	10.0 mm	6.0 mm			
PC2 72-9330	6.0 mm	10.0 mm	PC2 72-9341	10.0 mm	8.0 mm			
PC2 72-9331	8.0 mm	10.0 mm	PC2 72-9342	10.0 mm	13.0 mm			
PC2 72-9332	8.0 mm	12.0 mm	PC2 72-9343	12.0 mm	8.0 mm			
PC2 72-9333	10.0 mm	12.0 mm	PC2 72-9344	12.0 mm	10.0 mm			
			PC2 72-9345	15.0 mm	6.0 mm			
			PC2 72-9346	15.0 mm	8.0 mm			
			PC2 72-9347	18.0 mm	10.0 mm			
			PC2 72-9348	18.0 mm	15.0 mm			

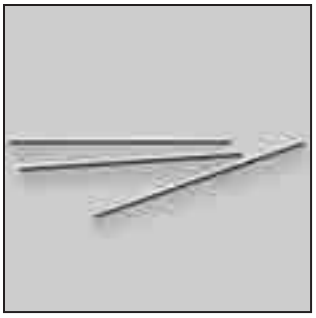
Extension Tubing & Connectors (continued)

Extension Tubing for 2 and 3-Stop Collared Tubing

Extension Tubing is required for extending the tube line on the suction and discharge side of 2 and 3-stop tubing.

There are five different materials available; Tygon® ST (R-3603/R-3607), PharMed® (Ismaprene), Tygon® (MHSL2001), Tygon® HC (F-404A) and Silicone (Peroxide).

	Tygon® ST R-3603/ R-3607 (1 Roll of 10 m)	PharMed® Ismaprene (1 Roll of 3 m)	Tygon® MHSL2001 (1 Roll of 10 m)	Tygon® HC F-4040-A (1 Roll of 3 m)	Silicone Peroxide (1 Roll of 15 m)
Tube ID (mm)	ORDER #	ORDER #	ORDER #	ORDER #	ORDER #
0.13	PC2 72-9174	–	–	–	–
0.19	PC2 72-9175	–	–	–	–
0.25	PC2 72-9176	PC2 72-9200	–	PC2 72-9223	–
0.38	PC2 72-9177	PC2 72-9201	PC2 72-9217	PC2 72-9224	–
0.44	PC2 72-9178	–	–	–	–
0.51	PC2 72-9179	PC2 72-9202	–	PC2 72-9225	–
0.57	PC2 72-9180	–	–	–	–
0.64	PC2 72-9181	PC2 72-9203	PC2 72-9218	PC2 72-9226	PC2 72-9240
0.76	PC2 72-9182	PC2 72-9204	–	PC2 72-9227	PC2 72-9241
0.89	PC2 72-9183	PC2 72-9205	–	PC2 72-9228	PC2 72-9242
0.95	PC2 72-9184	–	–	–	–
1.02	PC2 72-9185	PC2 72-9206	PC2 72-9219	PC2 72-9229	PC2 72-9243
1.09	PC2 72-9186	–	–	–	–
1.14	PC2 72-9187	PC2 72-9207	–	PC2 72-9230	PC2 72-9244
1.22	PC2 72-9188	–	–	–	–
1.30	PC2 72-9189	PC2 72-9208	–	PC2 72-9231	PC2 72-9245
1.42	PC2 72-9190	PC2 72-9209	–	PC2 72-9232	PC2 72-9246
1.52	PC2 72-9191	PC2 72-9210	PC2 72-9220	PC2 72-9233	PC2 72-9247
1.65	PC2 72-9192	PC2 72-9211	–	PC2 72-9234	PC2 72-9248
1.75	PC2 72-9193	–	–	–	–
1.85	PC2 72-9194	PC2 72-9212	–	PC2 72-9235	PC2 72-9249
2.06	PC2 72-9195	PC2 72-9213	PC2 72-9221	PC2 72-9236	PC2 72-9250
2.29	PC2 72-9196	PC2 72-9214	–	PC2 72-9237	PC2 72-9251
2.54	PC2 72-9197	PC2 72-9215	–	PC2 72-9238	PC2 72-9252
2.79	PC2 72-9198	PC2 72-9216	PC2 72-9222	PC2 72-9239	PC2 72-9253
3.17	PC2 72-9199	–	–	–	–



Stainless Steel Standard Tube Connectors

The Stainless Steel Tube Connectors are designed to assist you in quickly and easily making connections between 2 and 3-Stop Collared Tubing of similar sizes. They are supplied non-sterile in packages of 6.

ORDER #	Tube ID (mm)	Tube OD (mm)	Connector Length (mm)
PC2 72-9254	0.30	0.63	15
PC2 72-9255	0.58	0.90	15
PC2 72-9256	0.58	0.90	11
PC2 72-9257	0.84	1.27	11
PC2 72-9258	0.84	1.27	16
PC2 72-9259	0.30	0.63	25
PC2 72-9260	0.58	0.90	25
PC2 72-9261	0.58	0.90	19

Centrifugal Pump for Blood

Centrifugal Pump

KEY FEATURES

- Low hemolysis
- Flow rates up to 16 L/min
- Little to no 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
- Analog 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. The Pump Drive and Pump Head must be purchased separately. 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.

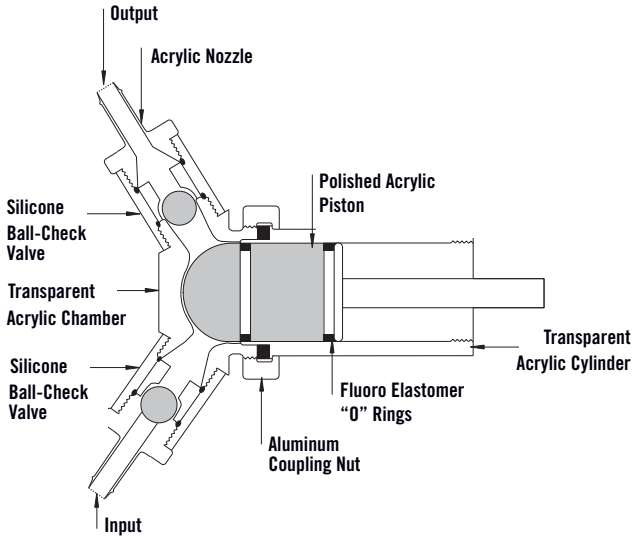
The drive is very robust and suitable for continuous speed selection operation.

Centrifugal Pump 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

Order #	Product
PC2 73-2963	BVP-ZX Centrifugal Pump Drive, 115 VAC, 50/60 Hz
PC2 73-2470	BVP-ZX Centrifugal Pump Drive, 230 VAC, 50/60 Hz
PC2 73-2807	BP-80 Centrifugal Pump Head
PC2 73-2954	BP-50 Centrifugal Pump Head
PC2 73-2955	SP-45 Centrifugal Pump Head
PC2 73-2956	SP-03 Adaptor for SP-45 Head

Note: Pump Drive and Pump Head must be purchased separately.

Harvard Apparatus Pulsatile Blood Pumps



KEY FEATURES

- 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 PTFE 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.

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.

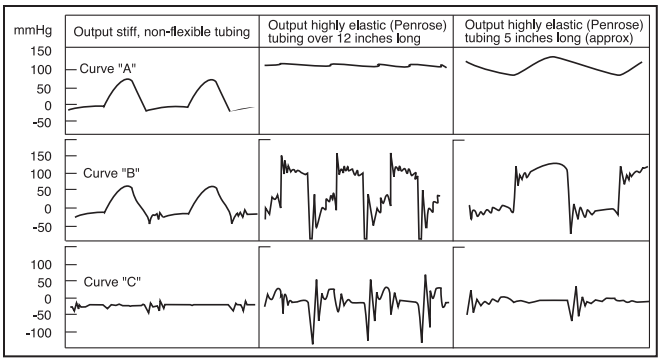
Specials - Harvard Apparatus now offers the pumping head in polysulfone which is autoclavable. The standard models use acrylic which must be sterilized using ethylene oxide or other methods. This new material makes it much easier to maintain sterility.

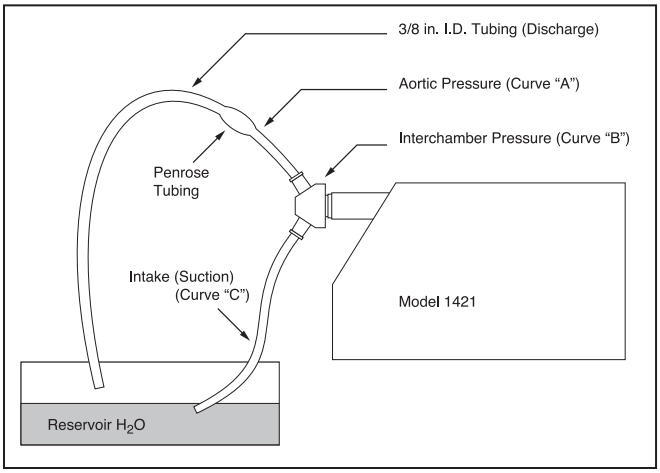
Harvard Apparatus now also offers a new control method for the blood pumps. Now the pump can be controlled from an external voltage source; 0 to 10 volt DC signal can be used to control the stroke rate and phasing of the pump. External control interfaces the blood pump with a computer to generate advanced cardiovascular waveforms and more control over pressure curves. Please call for more information.

Harvard Apparatus Pulsatile Blood Pump Specifications

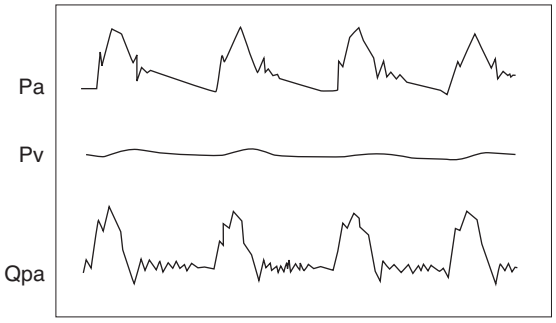
	Mice/Rats: Model 1407	Rabbits: Model 1405	Dogs/Monkeys: Model 1421	Large Animals; Hemodynamic Studies: Model 1423
STROKE VOLUME, ADJUSTABLE	0.05 to 1.0 ml	0.5 to 10 ml	4 to 30 ml	15 to 100 ml
RATE, STROKE/MIN.	20 to 200	20 to 200	20 to 200	10 to 100
MINUTE VOLUME, STROKE VOL. x RATE	1 to 200 ml	10 to 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,	35% systole,	35% to 50%	35% to 50%
TUBE ID	8 mm (0.31 in)	8 mm (0.31 in)	13 mm (0.5 in)	15.9 mm (0.625 in)
DIMENSIONS, H x W x D	312 x 156 x 250 mm (12.3 x 6.1 x 9.9 in)	312 x 156 x 250 mm (12.3 x 6.1 x 9.9 in)	500 x 212 x 337 mm (19.7 x 8.4 x 13.4 in)	500 x 212 x 337 mm (19.7 x 8.4 x 13.4 in)
WEIGHT	7.3 kg (16 lbs)	7.3 kg (16 lbs)	13.6 kg (30 lbs)	14.5 kg (32 lbs)
VOLTAGE	115 VAC, 50/60 Hz or 230 VAC, 50/60 Hz UK and EU Models	115 VAC, 50/60 Hz or 230 VAC, 50/60 Hz UK and EU Models	115 VAC, 50/60 Hz or 230 VAC, 50/60 Hz UK and EU Models	115 VAC, 50/60 Hz or 230 VAC, 50/60 Hz UK and EU Models
ORDER #	**PC2 52-9552**	**PC2 55-1838**	**PC2 55-3321**	**PC2 55-3305**
	PC2 52-9552UK	**PC2 55-1838UK**	**PC2 55-3321UK**	**PC2 55-3305UK**
	PC2 52-9552EU	**PC2 55-1838EU**	**PC2 55-3321EU**	**PC2 55-3305EU**

Harvard Apparatus Pulsatile Blood Pumps
(continued)





Pressure and Flow Curves Using Harvard Pulsatile Blood Pump for Dogs/Monkeys 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.*

Pressure Curves

The shape of the output pressure curve is a function of both the pump action and the characteristics of the external system on the output valve side. The following set of curves were obtained with Model 1421, using water as the pumped medium. In the tests, "Sanborn" pressure transducers were inserted in three places, and continuous records obtained under varying conditions.

Curve A	Pressure just beyond the output valve
Curve B	Pressure within the pump chamber
Curve C	Pressure just before the intake valve

By variation of parameters involved (peripheral resistance, stroke rate, stroke volume and phase ratio), an infinite number of output flow characteristics can be obtained.

Hemolysis Test Conditions Models for Dog/Monkey (PC2 55-5321) and Large Animals (PC2 55-3305)

Hemolysis ranged from 0.114 mg% to 0.29 mg% per pass through the various pumps, with an error of ±10%.

To put these results in perspective, most physiological perfusions are run with flow rates and total blood primes, such that the number of passes through the pump will range from about 1/4 to 3/4 per minute. Assuming one pass in two minutes and no physiological removal of the products of hemolysis, then hemolysis rates would range from 3.4 mg% to 8.7 mg% per hour of pump use.

In these studies a reservoir of 500-800 cc of fresh dog blood was used, connected to the pump by 3/8" PVC tubing. Samples at room temperature were taken at 15 and 30 minute intervals for 4 to 5 hours. Samples were spun down and hemolysis measured immediately using the method of Flink and Watson. Since the rate of hemolysis depends on the amount of blood in the system and the flow rate, the results are reported as mg% per pass. The flow rate divided by the volume of blood in the system determines the number of passes through the pump per minute.

Priming Kit, Compression Fittings and PEEK Tubing

Priming Kit

The Priming Kit provides the necessary tools to ensure that the syringe and needle connection is completely primed. Trapped air can cause inaccurate dispenses and standard priming techniques are not sufficient when using capillary tubing. The glass capillary tubing traps a large volume of liquid that can only be overcome by using the priming kit. The Priming Kit contains one 250 µl Syringe, one 6 pack of 30 gauge needles, and one pack of septa.

The 1 mm RN Compression Fitting is designed to attach pulled glass pipettes directly to a small hub RN connection. The RN nut compresses the conical PFA ferrule into the PEEK cup ferrule creating a seal between the syringe barrel and the glass capillary tubing. The connection requires no modifications to the glass capillary tubing.

The 1/16 in RN Compression Fitting is designed to attach 1/16 in PEEK tubing directly to a small hub RN connection. Tightening the RN nut compresses the conical PFA ferrule into the PEEK cup ferrule creating a seal between the syringe barrel and the PEEK tubing. The connection requires no modifications to the PEEK tubing. The RN Compression Fittings consist of one large bore RN nut, 5 PFA ferrules and 5 PEEK cup ferrules. They are compatible with 2.5-100 µl RN syringes.

The Dual Small Hub RN Coupler is constructed from model 1702 glass with a small hub RN termination on either end. It uses a standard glass size for compatibility with most stereotaxic instrumentation. The coupler is ideal for remotely connecting a syringe to a needle via PEEK tubing. It is also used with the Luer to RN adaptor for connection of custom needles to a 7000 series syringe. The Dual RN Coupler consists of two large bore RN nuts, and one dual RN barrel.

The Luer to Small Hub RN Adaptor consists of a Metal Luer Lock Hub and a Small Removable Needle Hub combined in a single needle. The Luer to RN Adaptor and the Dual RN Coupler can be used to connect a 7000 series syringe to any Small Hub Removable Needle or to a Pulled Glass Pipette. The Adaptor creates a rigid connection between the syringe and the needle as well as compatibility with stereotaxic instrumentation. The Luer to RN Adaptor consists of one RN to Luer Needle and a sealing ferrule for a 25 gauge 7000 series needle.

Order #	Model	Product
PC2 72-9354	PRMKIT	Priming Kit
PC2 72-9353	55750-01	RN Compression Fitting 1 mm
PC2 72-9376	55751-01	RN Compression Fitting 1/16 in
PC2 72-9377	55752-01	Dual Small Hub RN Coupler
PC2 72-9378	55753-01	Luer to Small Hub RN Adaptor

PEEK Semi-Flexible Tubing

PEEK semi-rigid tubing is manufactured from a unique, high temperature engineering thermoplastic that is suitable for a wide range of demanding applications. Designed to withstand high pressure and temperature levels, PEEK Tubing resists even the harshest environmental conditions. Semi-rigid PEEK tubing is insoluble in virtually all organic and inorganic solvents as well as having good dielectric properties. It can be cut to length, accepts pressure fittings and readily stands up to shock, abrasion and impacts. PEEK can be sterilized with Gamma, ETO and is autoclavable.

Order #	Product
PC2 72-5332	PEEK Semi-Flexible Tubing, 0.006 in ID x 0.062 in OD x 0.028 in Wall Thickness, 5 ft
PC2 72-5333	PEEK Semi-Flexible Tubing, 0.010 in ID x 0.062 in OD x 0.026 in Wall Thickness, 5 ft
PC2 72-5334	PEEK Semi-Flexible Tubing, 0.020 in ID x 0.062 in OD x 0.021 in Wall Thickness, 5 ft
PC2 72-5335	PEEK Semi-Flexible Tubing, 0.030 in ID x 0.062 in OD x 0.016 in Wall Thickness, 5 ft
PC2 72-5336	PEEK Semi-Flexible Tubing, 0.040 in ID x 0.062 in OD x 0.011 in Wall Thickness, 5 ft

Laboratory Tubing

Harvard Apparatus 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 technical support 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 kit features a selection of similarly sized connectors in one convenient container. All the individual kit components can be reordered.

Tygon® Long Flex Life Pump Tubing (E-LFL)

Tygon® E-LFL

KEY FEATURES

- 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® Long Flex Life Pump Tubing (E-LFL)

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-0983	1.6	4.8	1/16	3/16	7.6	25
PC2 72-0984	3.2	6.4	1/8	1/4	7.6	25
PC2 72-0985	4.8	7.9	3/16	5/16	7.6	25
PC2 72-0986	6.4	9.5	1/4	3/8	7.6	25
PC2 72-0987	6.4	12.7	1/4	1/2	7.6	25
PC2 72-0988	7.9	11.1	5/16	7/16	7.6	25
PC2 72-0989	9.5	15.9	3/8	5/8	7.6	25
PC2 72-0990	12.7	19.1	1/2	3/4	7.6	25
PC2 72-0991	19.1	31.8	3/4	1-1/4	3.0	10
PC2 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® Tubing

Tygon® Norprene®

KEY FEATURES

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

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® Tubing

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-0946	1.6	4.8	1/16	3/16	15.2	50
PC2 72-0947	3.2	6.4	1/8	1/4	15.2	50
PC2 72-0948	4.8	7.9	3/16	5/16	15.2	50
PC2 72-0949	6.4	9.5	1/4	3/8	15.2	50
PC2 72-0950	6.4	12.7	1/4	1/2	15.2	50
PC2 72-0951	7.9	11.1	5/16	7/16	15.2	50
PC2 72-0952	9.5	12.7	3/8	1/2	15.2	50
PC2 72-0953	9.5	15.9	3/8	5/8	15.2	50
PC2 72-0954	12.7	19.1	1/2	3/4	15.2	50
PC2 72-0955	15.9	22.2	5/8	7/8	15.2	50
PC2 72-0956	19.1	25.4	3/4	1	15.2	50

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

Laboratory Tubing (continued)

Tygon® Laboratory Tubing (R-3603)

Tygon® R-3603

KEY FEATURES

- 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, it's 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® Laboratory Tubing (R-3603)

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-1014	0.8	2.4	1/32	3/32	15.2	50
PC2 72-1015	1.6	3.2	1/16	1/8	15.2	50
PC2 72-1016	1.6	4.8	1/16	3/16	15.2	50
PC2 72-1017	2.4	4.0	3/32	5/32	15.2	50
PC2 72-1018	2.4	5.6	3/32	7/32	15.2	50
PC2 72-1019	3.2	4.8	1/8	3/16	15.2	50
PC2 72-1020	3.2	6.4	1/8	1/4	15.2	50
PC2 72-1021	4.0	5.6	5/32	7/32	15.2	50
PC2 72-1022	4.0	7.1	5/32	9/32	15.2	50
PC2 72-1023	4.8	6.4	3/16	1/4	15.2	50
PC2 72-1024	4.8	7.9	3/16	5/16	15.2	50
PC2 72-1025	6.4	7.9	1/4	5/16	15.2	50
PC2 72-1026	6.4	9.5	1/4	3/8	15.2	50
PC2 72-1027	7.9	11.1	5/16	7/16	15.2	50
PC2 72-1028	7.9	14.3	5/16	9/16	15.2	50
PC2 72-4621	9.5	12.7	3/8	1/2	15.2	50
PC2 72-1029	9.5	14.3	3/8	9/16	15.2	50
PC2 72-1030	9.5	15.9	3/8	5/8	15.2	50
PC2 72-1031	11.1	15.9	7/16	5/8	15.2	50
PC2 72-1032	11.1	17.5	7/16	11/16	15.2	50
PC2 72-1033	12.7	17.5	1/2	11/16	15.2	50
PC2 72-1034	12.7	19.1	1/2	3/4	15.2	50
PC2 72-1035	14.3	19.1	9/16	3/4	15.2	50
PC2 72-1036	14.3	20.6	9/16	13/16	15.2	50
PC2 72-1037	15.9	20.6	5/8	13/16	15.2	50
PC2 72-1038	15.9	22.2	5/8	7/8	15.2	50
PC2 72-1039	17.5	22.2	11/16	7/8	15.2	50
PC2 72-1040	19.1	25.4	3/4	1	15.2	50
PC2 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

Tygon® B-44-4X

KEY FEATURES

- Non-wetting surface permits thorough cleaning and 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 bacteria-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 inhibits 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 and Gas (Ethylene Oxide) sterilizable. Durometer Hardness Shore A, 65.*

Tygon® B-44-4X Tubing

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-0921	0.8	2.4	1/32	3/32	15.2	50
PC2 72-0922	1.6	3.2	1/16	1/8	15.2	50
PC2 72-0923	1.6	4.8	1/16	3/16	15.2	50
PC2 72-0924	2.4	4.0	3/32	5/32	15.2	50
PC2 72-0926	3.2	4.8	1/8	3/16	15.2	50
PC2 72-0927	3.2	6.4	1/8	1/4	15.2	50
PC2 72-0928	4.0	5.6	5/32	7/32	15.2	50
PC2 72-0929	4.0	7.1	5/32	9/32	15.2	50
PC2 72-0930	4.8	6.4	3/16	1/4	15.2	50
PC2 72-0931	4.8	7.9	3/16	5/16	15.2	50
PC2 72-0932	6.4	7.9	1/4	5/16	15.2	50
PC2 72-0933	6.4	9.5	1/4	3/8	15.2	50
PC2 72-0934	7.9	11.1	5/16	7/16	15.2	50
PC2 72-0935	7.9	12.7	5/16	1/2	15.2	50
PC2 72-0936	9.5	14.3	3/8	9/16	15.2	50
PC2 72-0937	9.5	15.9	3/8	5/8	15.2	50
PC2 72-0938	11.1	14.3	7/16	9/16	15.2	50
PC2 72-0939	11.1	15.9	7/16	5/8	15.2	50
PC2 72-0940	12.7	17.5	1/2	11/16	15.2	50
PC2 72-0941	12.7	19.1	1/2	3/4	15.2	50
PC2 72-0942	14.3	19.1	9/16	3/4	15.2	50
PC2 72-0943	15.9	20.6	5/8	13/16	15.2	50
PC2 72-0944	15.9	22.2	5/8	7/8	15.2	50
PC2 72-0945	19.1	25.4	3/4	1	15.2	50

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

Laboratory Tubing (continued)

Tygon® PharMed® Tubing

Tygon® PharMed® Tubing

KEY FEATURES

- 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® Tubing

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-0957	0.5	3.7	0.020	0.144	7.6	25
PC2 72-0958	0.8	4.0	1/32	5/32	7.6	25
PC2 72-0959	1.6	3.2	1/16	1/8	7.6	25
PC2 72-0960	1.6	4.8	1/16	3/16	7.6	25
PC2 72-0961	2.4	5.6	3/32	7/32	7.6	25
PC2 72-0962	3.2	4.8	1/8	3/16	7.6	25
PC2 72-0963	3.2	6.4	1/8	1/4	7.6	25
PC2 72-0964	4.8	7.9	3/16	5/16	7.6	25
PC2 72-0965	6.4	9.5	1/4	3/8	7.6	25
PC2 72-0966	6.4	12.7	1/4	1/2	7.6	25
PC2 72-0967	7.9	11.1	5/16	7/16	7.6	25
PC2 72-0968	9.5	12.7	3/8	1/2	7.6	25
PC2 72-0969	9.5	15.9	3/8	5/8	7.6	25
PC2 72-0970	12.7	19.1	1/2	3/4	7.6	25
PC2 72-0971	15.9	22.2	5/8	7/8	7.6	25
PC2 72-0972	19.1	25.4	3/4	1	7.6	25

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

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

Tygon® S-50-HL

KEY FEATURES

- Crystal clear
- Ideal for blood contact
- Flexible and resilient with established performance in peristaltic pump
- 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® Medical/Surgical Tubing (S-50-HL)

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-1249	0.8	2.4	1/32	3/32	15.2	50
PC2 72-1248	1.6	3.2	1/16	1/8	15.2	50
PC2 72-1255	1.6	4.7	1/16	3/16	15.2	50
PC2 72-1253	2.4	3.9	3/32	5/32	15.2	50
PC2 72-1257	2.4	5.5	3/32	7/32	15.2	50
PC2 72-1251	3.2	4.7	1/8	3/16	15.2	50
PC2 72-1259	3.2	6.3	1/8	1/4	15.2	50
PC2 72-1254	3.9	5.5	5/32	7/32	15.2	50
PC2 72-1258	3.9	7.1	5/32	9/32	15.2	50
PC2 72-1252	4.7	6.3	3/16	1/4	15.2	50
PC2 72-1262	4.7	7.9	3/16	5/16	15.2	50
PC2 72-1250	6.3	7.9	1/4	5/16	15.2	50
PC2 72-1256	6.3	9.5	1/4	3/8	15.2	50
PC2 72-1260	7.9	11.0	5/16	7/16	15.2	50
PC2 72-1265	7.9	12.6	5/16	1/2	15.2	50
PC2 72-1264	9.5	14.2	3/8	9/16	15.2	50
PC2 72-1270	9.5	15.8	3/8	5/8	15.2	50
PC2 72-1261	11.0	14.2	7/16	9/16	15.2	50
PC2 72-1267	11.0	15.8	7/16	5/8	15.2	50
PC2 72-1263	12.6	17.3	1/2	11/16	15.2	50
PC2 72-1268	12.6	18.9	1/2	3/4	15.2	50
PC2 72-1272	14.2	18.9	9/16	3/4	15.2	50
PC2 72-1266	15.8	20.5	5/8	13/16	15.2	50
PC2 72-1271	15.8	22.1	5/8	7/8	15.2	50
PC2 72-1269	18.9	25.2	3/4	1	15.2	50

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

Laboratory Tubing (continued)

Tygon® Ultra-Soft Tubing (E-1000)

Tygon® E-1000

KEY FEATURES

- 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 65

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® Ultra-Soft Tubing (E-1000)

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-0998	1.6	4.8	1/16	3/16	15.2	50
PC2 72-0999	3.2	6.4	1/8	1/4	15.2	50
PC2 72-1000	4.8	7.9	3/16	5/16	15.2	50
PC2 72-1001	6.4	9.5	1/4	3/8	15.2	50
PC2 72-1002	6.4	12.7	1/4	1/2	15.2	50
PC2 72-1003	7.9	11.1	5/16	7/16	15.2	50
PC2 72-1004	9.5	12.7	3/8	1/2	15.2	50
PC2 72-1005	9.5	15.9	3/8	5/8	15.2	50
PC2 72-1006	12.7	15.9	1/2	5/8	15.2	50
PC2 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 (2375)

Tygon® 2375

KEY FEATURES

- Suitable for most gas anesthesia applications
- Temperature resistant from -60° to 275°F
- Compatible with virtually all common sanitizers and cleaners
- 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. Do not autoclave. Durometer hardness: Shore A, 75.*

Tygon® Ultra Chemical Resistant Tubing (2375)

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-4119	1.6	4.8	1/16	3/16	15.2	50
PC2 72-4120	3.2	6.4	1/8	1/4	15.2	50
PC2 72-4121	4.8	7.9	3/16	5/16	15.2	50
PC2 72-4122	6.4	9.5	1/4	3/8	15.2	50
PC2 72-4123	7.9	11.1	5/16	7/16	15.2	50
PC2 72-4124	9.5	12.7	3/8	1/2	15.2	50
PC2 72-4125	12.7	19.1	1/2	3/4	15.2	50
PC2 72-4126	15.9	22.2	5/8	7/8	15.2	50
PC2 72-4127	19.1	25.4	3/4	1	15.2	50
PC2 72-4128	25.4	34.9	1	1-3/8	7.6	25

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

Laboratory Tubing (continued)

FEP Semi-Flexible Tubing

KEY FEATURES

- Excellent chemical resistance even at extreme temperatures from -348° 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 Semi-Flexible Tubing

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-1169	1.6	3.2	1/16	1/8	7.6	50
PC2 72-1188	1.6	4.8	1/16	3/16	7.6	50
PC2 72-1174	2.4	2.4	3/32	3/32	7.6	50
PC2 72-1175	2.4	4.0	3/32	5/32	7.6	50
PC2 72-1172	3.2	4.8	1/8	3/16	7.6	50
PC2 72-1189	3.2	6.4	1/8	1/4	7.6	50
PC2 72-1179	4.0	6.4	5/32	1/4	7.6	50
PC2 72-1173	4.8	6.4	3/16	1/4	7.6	50
PC2 72-1190	4.8	7.9	3/16	5/16	7.6	50
PC2 72-1171	6.4	7.9	1/4	5/16	7.6	50
PC2 72-1191	6.4	9.5	1/4	3/8	7.6	50
PC2 72-1178	7.9	9.5	5/16	3/8	3.0	50
PC2 72-1192	7.9	11.1	5/16	7/16	3.0	50
PC2 72-1177	9.5	11.1	3/8	7/16	3.0	50
PC2 72-1193	9.5	12.7	3/8	1/2	3.0	50
PC2 72-1176	11.1	12.7	7/16	1/2	3.0	50
PC2 72-1170	12.7	14.3	1/2	9/16	3.0	50
PC2 72-1195	12.7	15.9	1/2	5/8	3.0	50
PC2 72-1184	14.3	15.9	9/16	5/8	3.0	50
PC2 72-1196	14.3	17.5	9/16	11/16	3.0	50
PC2 72-1180	15.9	17.5	5/8	11/16	3.0	50
PC2 72-1197	15.9	19.1	5/8	3/4	3.0	50
PC2 72-1182	17.5	19.1	11/16	3/4	3.0	50
PC2 72-1198	17.5	20.6	11/16	13/16	3.0	50
PC2 72-1181	19.1	20.6	3/4	13/16	3.0	50
PC2 72-1199	19.1	22.2	3/4	7/8	3.0	50
PC2 72-1183	22.2	23.8	7/8	15/16	3.0	50
PC2 72-1200	22.2	25.4	7/8	1	3.0	50
PC2 72-1187	25.4	27.0	1	1-1/16	3.0	50
PC2 72-1201	25.4	28.6	1	1-1/8	3.0	50
PC2 72-1186	31.8	33.3	1-1/4	1-5/16	3.0	50
PC2 72-1202	31.8	34.9	1-1/4	1-3/8	3.0	50
PC2 72-1185	38.1	39.7	1-1/2	1-9/16	3.0	50
PC2 72-1203	38.1	41.3	1-1/2	1-5/8	3.0	50

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

PFA Semi-Flexible Tubing

KEY FEATURES

- Excellent chemical resistance
- UV and ozone resistant
- Suitable for a wide range of temperature applications from -320° 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 Semi-Flexible Tubing

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-1134	1.6	3.2	1/16	1/8	7.6	50
PC2 72-1135	2.4	4.0	3/32	5/32	7.6	50
PC2 72-1136	3.2	4.8	1/8	3/16	7.6	50
PC2 72-1154	3.2	6.4	1/8	1/4	7.6	50
PC2 72-1137	4.0	6.4	5/32	1/4	7.6	25
PC2 72-1138	4.8	6.4	3/16	1/4	7.6	50
PC2 72-1155	4.8	7.9	3/16	5/16	7.6	50
PC2 72-1139	6.4	7.9	1/4	5/16	3.0	25
PC2 72-1156	6.4	9.5	1/4	3/8	3.0	50
PC2 72-1140	7.9	9.5	5/16	3/8	3.0	50
PC2 72-1157	7.9	11.1	5/16	7/16	3.0	50
PC2 72-1141	9.5	11.1	3/8	7/16	3.0	50
PC2 72-1158	9.5	12.7	3/8	1/2	3.0	50
PC2 72-1142	11.1	12.7	7/16	1/2	3.0	50
PC2 72-1159	11.1	14.3	7/16	9/16	3.0	50
PC2 72-1143	12.7	14.3	1/2	9/16	3.0	50
PC2 72-1160	12.7	15.9	1/2	5/8	3.0	50
PC2 72-1147	14.3	15.9	9/16	5/8	3.0	50
PC2 72-1168	14.3	17.5	9/16	11/16	3.0	50
PC2 72-1144	15.9	17.5	5/8	11/16	3.0	50
PC2 72-1166	15.9	19.1	5/8	3/4	3.0	50
PC2 72-1145	17.5	19.1	11/16	3/4	3.0	50
PC2 72-1161	17.5	20.6	11/16	13/16	3.0	50
PC2 72-1146	19.1	20.6	3/4	13/16	3.0	50
PC2 72-1165	19.1	22.2	3/4	7/8	3.0	50
PC2 72-1148	22.2	23.8	7/8	15/16	3.0	50
PC2 72-1167	22.2	25.4	7/8	1	3.0	50
PC2 72-1149	25.4	27.0	1	1-1/16	3.0	50
PC2 72-1152	25.4	28.6	1	1-1/8	3.0	50
PC2 72-1150	31.8	33.3	1-1/4	1-5/16	3.0	50
PC2 72-1163	31.8	34.9	1-1/4	1-3/8	3.0	50
PC2 72-1151	38.1	39.7	1-1/2	1-9/16	3.0	50
PC2 72-1162	38.1	41.3	1-1/2	1-5/8	3.0	50
PC2 72-1164	50.8	54.0	2	2-1/8	3.0	50

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

Tygon® Fluran® Severe Environment Tubing

KEY FEATURES

- 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® Severe Environment Tubing

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-1008	1.6	3.2	1/16	1/8	15.2	50
PC2 72-1009	3.2	6.4	1/8	1/4	15.2	50
PC2 72-1010	4.8	7.9	3/16	5/16	15.2	50
PC2 72-1011	6.4	9.5	1/4	3/8	15.2	50
PC2 72-1012	7.9	11.1	5/16	7/16	15.2	50
PC2 72-1013	9.5	12.7	3/8	1/2	15.2	50

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

Platinum Cured Silicone Tubing

KEY FEATURES

- 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 Tubing

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-1042	0.3	0.6	0.012	0.024	7.6	25
PC2 72-1043	0.5	0.9	0.020	0.036	7.6	25
PC2 72-1044	0.6	1.2	0.025	0.047	7.6	25
PC2 72-1045	0.8	1.7	0.030	0.066	7.6	25
PC2 72-1046	0.8	4.1	0.030	0.160	7.6	25
PC2 72-4189	0.8	2.4	1/32	3/32	15.2	50
PC2 72-1047	1.0	2.2	0.040	0.086	7.6	25
PC2 72-1048	1.5	1.9	0.058	0.076	7.6	25
PC2 72-1050	1.6	3.2	1/16	1/8	7.6	25
PC2 72-1049	1.6	4.8	1/16	3/16	7.6	25
PC2 72-1054	1.6	6.4	1/16	1/4	7.6	25
PC2 72-1052	1.6	7.9	1/16	5/16	7.6	25
PC2 72-1053	1.6	11.1	1/16	7/16	7.6	25
PC2 72-1051	1.6	14.3	1/16	9/16	7.6	25
PC2 72-1056	2.0	3.6	5/64	9/64	7.6	25
PC2 72-1055	2.0	5.2	5/64	13/64	7.6	25
PC2 72-1060	2.0	6.7	5/64	17/64	7.6	25
PC2 72-1058	2.0	8.3	5/64	21/64	7.6	25
PC2 72-1059	2.0	11.5	5/64	29/64	7.6	25
PC2 72-1057	2.0	14.7	5/64	37/64	3.0	10
PC2 72-1062	2.4	4.0	3/32	5/32	7.6	25
PC2 72-1061	2.4	5.6	3/32	7/32	7.6	25
PC2 72-1066	2.4	7.1	3/32	9/32	7.6	25
PC2 72-1064	2.4	8.7	3/32	11/32	7.6	25

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

Laboratory Tubing (continued)

Platinum Cured Silicone Tubing (continued)

Platinum Cured Silicone Tubing

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-1065	2.4	11.9	3/32	15/32	7.6	25
PC2 72-1063	2.4	15.1	3/32	19/32	7.6	25
PC2 72-1068	3.2	4.8	1/8	3/16	7.6	25
PC2 72-1067	3.2	6.4	1/8	1/4	7.6	25
PC2 72-1072	3.2	7.9	1/8	5/16	7.6	25
PC2 72-1070	3.2	9.5	1/8	3/8	7.6	25
PC2 72-1071	3.2	12.7	1/8	1/2	7.6	25
PC2 72-1069	3.2	15.9	1/8	5/8	7.6	25
PC2 72-1074	4.0	5.6	5/32	7/32	7.6	25
PC2 72-1073	4.0	7.1	5/32	9/32	7.6	25
PC2 72-1078	4.0	8.7	5/32	11/32	7.6	25
PC2 72-1076	4.0	10.3	5/32	13/32	7.6	25
PC2 72-1077	4.0	13.5	5/32	17/32	7.6	25
PC2 72-1075	4.0	16.7	5/32	21/32	3.0	10
PC2 72-1080	4.8	6.4	3/16	1/4	7.6	25
PC2 72-1079	4.8	7.9	3/16	5/16	7.6	25
PC2 72-1084	4.8	9.5	3/16	3/8	7.6	25
PC2 72-1082	4.8	11.1	3/16	7/16	7.6	25
PC2 72-1083	4.8	14.3	3/16	9/16	7.6	25
PC2 72-1081	4.8	17.5	3/16	11/16	3.0	10
PC2 72-1086	6.4	7.9	1/4	5/16	7.6	25
PC2 72-1085	6.4	9.5	1/4	3/8	7.6	25
PC2 72-1090	6.4	11.1	1/4	7/16	7.6	25
PC2 72-1088	6.4	12.7	1/4	1/2	7.6	25
PC2 72-1089	6.4	15.9	1/4	5/8	3.0	10
PC2 72-1087	6.4	19.1	1/4	3/4	3.0	10
PC2 72-1092	7.9	9.5	5/16	3/8	7.6	25
PC2 72-1091	7.9	11.1	5/16	7/16	7.6	25
PC2 72-1096	7.9	12.7	5/16	1/2	3.0	10
PC2 72-1094	7.9	14.3	5/16	9/16	3.0	10
PC2 72-1095	7.9	17.5	5/16	11/16	3.0	10
PC2 72-1093	7.9	20.6	5/16	13/16	3.0	10
PC2 72-1098	9.5	11.1	3/8	7/16	7.6	25

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

Platinum Cured Silicone Tubing

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-1097	9.5	12.7	3/8	1/2	7.6	25
PC2 72-1102	9.5	14.3	3/8	9/16	3.0	10
PC2 72-1100	9.5	15.9	3/8	5/8	3.0	10
PC2 72-1101	9.5	19.1	3/8	3/4	3.0	10
PC2 72-1099	9.5	22.2	3/8	7/8	3.0	10
PC2 72-1104	12.7	14.3	1/2	9/16	3.0	10
PC2 72-1103	12.7	15.9	1/2	5/8	3.0	10
PC2 72-1108	12.7	17.5	1/2	11/16	3.0	10
PC2 72-1106	12.7	19.1	1/2	3/4	3.0	10
PC2 72-1107	12.7	22.2	1/2	7/8	3.0	10
PC2 72-1105	12.7	25.4	1/2	1	3.0	10
PC2 72-1109	15.9	17.5	5/8	11/16	3.0	10
PC2 72-1110	15.9	19.1	5/8	3/4	3.0	10
PC2 72-1112	15.9	20.6	5/8	13/16	3.0	10
PC2 72-1113	15.9	22.2	5/8	7/8	3.0	10
PC2 72-1111	15.9	25.4	5/8	1	3.0	10
PC2 72-1115	19.1	20.6	3/4	13/16	3.0	10
PC2 72-1120	19.1	22.2	3/4	7/8	3.0	10
PC2 72-1118	19.1	23.8	3/4	15/16	3.0	10
PC2 72-1119	19.1	25.4	3/4	1	3.0	10
PC2 72-1116	19.1	28.6	3/4	1-1/8	3.0	10
PC2 72-1117	19.1	28.6	3/4	1-1/4	3.0	10
PC2 72-1121	22.2	23.8	7/8	15/16	3.0	10
PC2 72-1126	22.2	25.4	7/8	1	3.0	10
PC2 72-1124	22.2	27.0	7/8	1-1/16	3.0	10
PC2 72-1125	22.2	28.6	7/8	1-1/8	3.0	10
PC2 72-1122	22.2	31.8	7/8	1-1/4	3.0	10
PC2 72-1123	22.2	31.8	7/8	1-3/8	3.0	10
PC2 72-1130	25.4	31.8	1	1-1/4	3.0	10
PC2 72-1128	25.4	34.9	1	1-3/8	3.0	10
PC2 72-1129	25.4	38.1	1	1-1/2	3.0	10

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

Laboratory Tubing (continued)

Kynar/PVDF Tubing (Polyvinylidene Fluoride)

KEY FEATURES

- 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

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-1205	1.6	3.2	1/16	1/8	7.6	25
PC2 72-1206	3.2	4.8	1/8	3/16	7.6	25
PC2 72-1211	3.2	6.4	1/8	1/4	7.6	25
PC2 72-1208	4.3	6.4	8/47	1/4	7.6	25
PC2 72-1207	4.8	6.4	3/16	1/4	7.6	25
PC2 72-1212	4.8	7.9	3/16	5/16	7.6	25
PC2 72-1213	6.4	9.5	1/4	3/8	3.0	10
PC2 72-1209	7.9	9.5	5/16	3/8	7.6	25
PC2 72-1214	7.9	11.1	5/16	7/16	3.0	10
PC2 72-1215	9.5	12.7	3/8	1/2	3.0	10
PC2 72-1210	11.1	12.7	7/16	1/2	7.6	25
PC2 72-1216	12.7	15.9	1/2	5/8	3.0	10
PC2 72-1217	15.9	19.1	5/8	3/4	3.0	10
PC2 72-1218	19.1	22.2	3/4	7/8	3.0	10
PC2 72-1219	22.2	25.4	7/8	1	3.0	10

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

Tygon® Microbore Tubing (S-54-HL)

KEY FEATURES

- 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® Microbore Tubing (S-54-HL)

ORDER #	ID (mm)	OD (mm)	ID (in)	OD (in)	length (m)	length (ft)
PC2 72-0993	0.3	0.8	0.010	0.030	152.4	500
PC2 72-0994	0.5	1.5	0.020	0.060	152.4	500
PC2 72-0995	0.8	2.3	0.030	0.090	152.4	500
PC2 72-0996	1.0	1.8	0.040	0.070	152.4	500
PC2 72-0997	1.3	2.3	0.050	0.090	152.4	500

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

Laboratory Tubing (continued)

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.

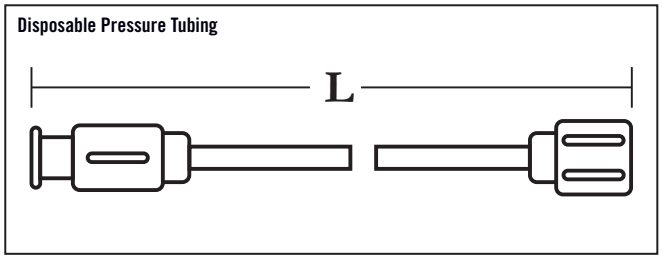
The mechanical properties of this material are unique. It has virtually 100% elastic memory and will return to its original shape after stretching by gentle heating. It will stretch to fit over tubes and fittings. Micro-Line™ Tubing can be shaped with heat to form various shapes or can be cold-stretched 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

ORDER #	ID (mm)	OD (mm)	ID (in.)	OD (in.)	length (m)	length (ft.)
PC2 59-8644	1.0	1.8	0.040	0.070	30.5	100
PC2 59-8645	1.3	2.3	0.050	0.090	30.5	100
PC2 59-8646	Set of 4 spools					

Disposable Pressure Tubing



KEY FEATURES

- 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. This tubing has an ID of 1.6 mm (1/16 in) and an OD of 3.2 mm (1/8 in). 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.

Disposable Pressure Tubing

Order #	Product
PC2 63-0281	Disposable Pressure Tubing, 15.2 cm (6 in)
PC2 63-0282	Disposable Pressure Tubing, 30.5 cm (12 in)
PC2 63-0283	Disposable Pressure Tubing, 61 cm (24 in)
PC2 63-0284	Disposable Pressure Tubing, 91.4 cm (36 in)
PC2 63-0286	Disposable Pressure Tubing, 152.4 cm (60 in)
PC2 63-0287	Disposable Pressure Tubing, 182.9 cm (72 in)
PC2 63-0288	Disposable Pressure Tubing, 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. This tubing has an ID of 1.6 mm (1/16 in) and an OD of 3.2 mm (1/8 in). Supplied as straight pieces of tubing in a package of 10.

Disposable High Pressure Tubing

Order #	Product
PC2 63-0297	Disposable High Pressure Tubing, 25.4 cm (10 in)
PC2 63-0299	Disposable High Pressure Tubing, 76.2 cm (30 in)

PolyE Polyethylene Tubing

Harvard Apparatus' PolyE polyethylene tubing is an excellent tubing choice for a variety of applications requiring small ID or OD tubing. It is available in both sterile and non-sterile packages. 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

			NEEDLE GAUGE	
ORDER #	PE No.	Diameter ID x OD	Needle In Tubing	Tubing In Needle
Length 30.5 cm (12 in)				
PC2 59-8357	50	0.58 x 0.965 mm (0.023 x 0.038 in)	23 g	17 g
Length 91.45 cm (36 in)				
PC2 59-8358	50	0.58 x 0.965 mm (0.023 x 0.038 in)	23 g	17 g
PC2 59-8360	90	0.86 x 1.27 mm (0.034 x 0.050 in)	20 g	15 g
PC2 59-8364	190	1.19 x 1.70 mm (0.047 x 0.067 in)	18 g	13 g
PC2 59-8370	240	1.67 x 2.42 mm (0.066 x 0.095 in)	15 g	10 g

PolyE Tubing Size Cross Reference Chart

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

French* Number	PolyE Number	OD (in)
1	-	0.013
1.8	100	0.024
2	-	0.026
2.4	140	0.031
2.9	200	0.038
3	160	0.039
3.2	120	0.043
3.8	260	0.050
4	-	0.052
4.6	280	0.060
4.7	320	0.062
5	-	0.066
5.1	340	0.067
5.9	300	0.078
6	-	0.079
6.2	420	0.082
7	-	0.092
7.2	460	0.095
8	-	0.105
8.1	380	0.106
9.0	500	0.118
9.8	520	0.128
10	-	0.131
11	540	0.145
11.6	605	0.153
12.3	580	0.161
13	-	0.171
14	-	0.184
15	-	0.197
16	-	0.210
17	-	0.223
17.9	680	0.236

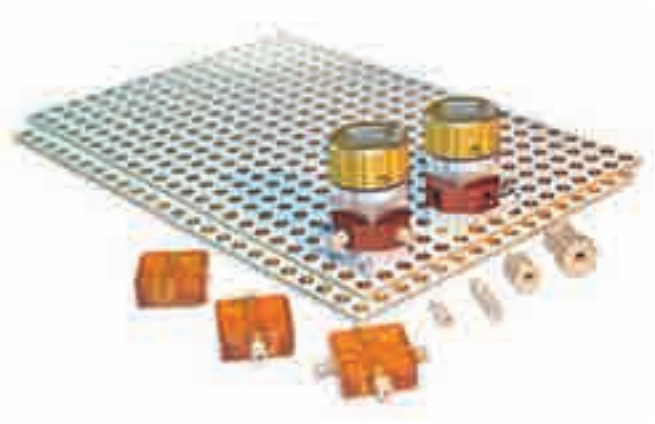
** French Scale = OD (in) x 76.211 - 0.0014*

Non-Sterile PolyE Polyethylene Tubing

Tubing Length 3m (10 ft)	30.5 m (100 ft)	PE No.	Diameter ID x OD mm (in)	Needle Gauge French Scale*	Needle Gauge Needle into Tubing	PE # Tubing into Needle	PolyE Equiv.
PC2 59-8321	PC2 59-8322	10	0.28 x 0.61 (0.011 x 0.024)	1.8	30 g	20 g	100
PC2 59-8323	PC2 59-8324	20	0.38 x 1.09 (0.015 x 0.042)	3.2	27 g	16 g	120
PC2 72-0191	PC2 72-0192	–	0.40 x 0.80 (0.016 x 0.031)	2.4	26 g	18 g	140
PC2 59-8325	PC2 59-8326	50	0.58 x 0.96 (0.023 x 0.038)	2.9	23 g	17 g	200
PC2 59-8329	PC2 59-8330	90	0.86 x 1.27 (0.034 x 0.050)	3.8	20 g	15 g	260
PC2 59-8331	PC2 59-8332	100	0.86 x 1.52 (0.034 x 0.060)	4.6	20 g	14 g	280
PC2 72-0195	PC2 72-0196	–	1.02 x 1.98 (0.04 x 0.078)	5.9	18 g	12 g	300
PC2 59-8341	PC2 59-8342	240	1.67 x 2.42 (0.066 x 0.095)	7.2	14 g	10 g	460
PC2 59-8343	PC2 59-8344	260	2.0 x 3.0 (0.079 x 0.118)	9.0	14 g	8 g	500
PC2 59-8345	PC2 59-8346	280	2.16 x 3.25 (0.085 x 0.128)	9.8	13 g	8 g	520
PC2 59-8347	PC2 59-8348	320	2.45 x 3.7 (0.096 x 0.145)	11.1	12 g	7 g	540
PC2 59-8349	PC2 59-8350	330	2.8 x 4.1 (0.110 x 0.161)	12.3	11 g	6 g	580
PC2 59-8351	PC2 59-8352	350	3.0 x 3.88 (0.118 x 0.153)	11.6	10 g	6 g	605
PC2 59-8355	PC2 59-8356	380	4.0 x 6.0 (0.157 x 0.236)	17.9	9 g	NA	680

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

CapTite™ Microfluidic Construction Kits



KEY FEATURES

- Compact components for 360 µm, 1/16, and 1/32 inch ID tubing
- Fast, breadboard-based design
- Leak-free high pressure setups

Routing fluids can be one of the most time-consuming tasks of microfluidics research. LabSmith's CapTite microminiature components take the pain out of constructing setups. Based on components developed by Sandia National Laboratories, these compact components for 360 µm and 1/16 in tubing are designed for leak-free connectivity, even at high pressures.

CapTite components are extremely compact — a welcome relief from bulky, multi-piece fittings and components. Setups for tasks such as one-step separations can be built up in a fraction of the time and footprint of other fittings.

CapTite components let you create complex setups, including complete sample prep and analysis systems, that cannot be easily built using other methods. You can also add bonded-port connections to route fluids through and between chips securely: no more world-to-chip headaches!

All CapTite components are designed for low dead volumes and easy cleaning, enabling long life over multiple runs. Complete construction kits are available, with everything you need to build up experiment after experiment, for great value with little waste, at a fraction of the price of other components.

Fully inter-compatible CapTite products enable easy, breadboard-based, microfluidic system construction. Most components are available for either 360 µm (0.014 in) capillary or 1/16 in (1.59 mm) tubing.

Complete Microfluidic Construction Kits include breadboard, interconnects, tubing, syringe adapter, and more. Choose from 360 µm Single User, 360 µm Capillary Interface, 360 µm Chip Interface or 1/16 in Single User kits. These kits offer the best value for prototype and permanent construction of microfluidic setups.

CapTite™ Microfluidic Construction Kits

ORDER #	QTY	MODEL	PRODUCT
Single User Kit			
PC2 72-0426		C360-KIT1	Microfluidic Construction Single User Kit for 360 µm capillary tubing
KIT COMPONENTS:			
PC2 72-0431	75	C360-100	One-Piece Fitting
PC2 72-0433	10	C360-101	Plug
PC2 72-0438	5	C360-203	Tee Interconnect
PC2 72-0443	5	C360-204	Cross Interconnect
PC2 72-0449	10	C360-300	Luer-Lock Adapter
PC2 72-0448	25	C360-400	Bonded Port Connector
PC2 72-0445	2	C360-500	Selector Valve
PC2 72-0430	2	LS-600	Breadboard
Interface Kit			
PC2 72-0427		C360-KIT2	Microfluidic Construction Interface Kit for 360 µm capillary tubing
KIT COMPONENTS:			
PC2 72-0431	50	C360-100	One-Piece Fitting
PC2 72-0433	5	C360-101	Plug
PC2 72-0438	5	C360-203	Tee Interconnect
PC2 72-0443	5	C360-204	Cross Interconnect
PC2 72-0449	10	C360-300	Luer-Lock Adapter
PC2 72-0445	2	C360-500	Selector Valve
PC2 72-0430	2	LS-600	Breadboard
Chip Interface Kit for 360 µm Capillary Tubing			
PC2 72-0428		C360-KIT3	Microfluidic Construction Chip Interface Kit for 360 µm capillary tubing
KIT COMPONENTS:			
PC2 72-0431	60	C360-100	One-Piece Fitting
PC2 72-0433	5	C360-101	Plug
PC2 72-0449	5	C360-300	Luer-Lock Adapter
PC2 72-0448	50	C360-400	Bonded Port Connector
Single User Kit for 1/16 Inch Tubing			
PC2 72-0429		T116-KIT1	Microfluidic Construction Single User Kit for 1/16 in tubing
KIT COMPONENTS:			
PC2 72-0432	50	T116-100	One-Piece Fitting
PC2 72-0434	5	T116-101	Plug
PC2 72-0441	5	T116-203	Tee Interconnect
PC2 72-0444	5	T116-204	Cross Interconnect
PC2 72-0450	10	T116-300	Luer-Lock Adapter
PC2 72-0446	2	T116-500	Selector Valve
PC2 72-0430	2	LS-600	Breadboard

CapTite™ Microfluidic Components

One-Piece Fitting

One-Piece Plug

Adapter

Interconnect

Bonded-port connectors

Luer-Lock™ Adapter

Multi-Port Selector Valve

Breadboard

Order #			Description
360 µm Capillary	1/32" Tubing	1/16" Tubing	
One-Piece Fitting - Secure connections from tubing to other components. Material: PEEK™			
PC2 72-0451	PC2 72-0452	PC2 72-0453	Set of 5
PC2 72-0454	PC2 72-0455	PC2 72-0456	Set of 25
One-Piece Plug - Use in place of one-piece fittings to plug ports. Material: PEEK™			
PC2 72-0457	PC2 72-0458	PC2 72-0459	Sets of 5
Adapter - Two-piece fittings to adapt capillary or tubing sizes. Material: PEEK™			
PC2 72-4691	PC2 72-4692	PC2 72-4693	Sets of 2
PC2 72-4694	PC2 72-4695	PC2 72-4696	Sets of 2
Interconnect - Breadboard mountable connector joins up to four fluid lines with zero dead volume. Material: Ultem®			
PC2 72-4995	PC2 72-4996	PC2 72-4997	Union (2 Unions & 4 one-piece fittings)
PC2 72-4998	PC2 72-4999	PC2 72-5000	Tee (2 Tees & 6 one-piece fittings)
PC2 72-5001	PC2 72-5002	PC2 72-5003	Cross (2 Crosses & 8 one-piece fittings)
PC2 72-5004	PC2 72-5005	PC2 72-5006	Elbow (2 Elbows & 4 one-piece fittings)
Bonded-port connectors - Attach to chip to secure removable capillary. Material: Ultem®			
PC2 72-5007	–	–	Set of 10 (10 one-piece fittings & epoxy)
PC2 72-5008	–	–	Set of 50 (connectors only)
Luer-Lock™ Adapter - Includes 4 one-piece fittings. Material: PEEK™			
PC2 72-4697	PC2 72-4698	PC2 72-4699	Sets of 4
Multi-Port Selector Valve - 3-way, manual with “L” flow pattern. Includes 3 one-piece fittings			
PC2 72-5009	PC2 72-5010	PC2 72-5011	
–	–	PC2 72-5012	
Breadboard - 4 x 6 inches. Includes 2 breadboards, installation tools, and hardware for mounting valves and interconnects			
PC2 72-5013	PC2 72-5013	PC2 72-5013	

Barbed Tubing Connectors

Tubing Connector Kits & Stopcocks

Harvard Apparatus 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: barbed connector kits (small, medium and large), Kent® Systems Quick Disconnect Kits, Luer connector kits, a stopcock kit, a tubing clamp kit, fitting and tubing kit and a tubing manifold 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 kit component are also sold separately. Our line of connectors grows continually. Visit our website for the latest offerings.

Luer and Barbed Connector Kits

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. Each kit is supplied in a convenient box. All kit components are also sold separately.

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

Order #	Barb Size	Kit Size	Tube ID Range
PC2 72-1613	004, 007, 013	Small	1/16, 3/32 and 1/8 in
PC2 72-1614	025, 035, 055	Large	5/32, 3/16 and 1/4 in

Barbed Tubing Connectors (continued)

Barbed Connector Kits


PC2 72-1409 Small Kit


PC2 72-1412 Medium Kit


PC2 72-1416 Large Kit

These barbed connector kits come in three different sizes. Small and medium kits have 10 pieces of each component and large kits have 5 pieces of each component. Connectors join tubing of similar sizes while reducing adapters join tubing of different sizes. These kits are available in black nylon, polypropylene, and Kynar®, a chemically resistant autoclavable plastic. Each kit is supplied in a convenient box. All kit components are also sold separately.

Barbed Tubing Connector Kits

ORDER #	PRODUCT	TUBE ID	MATERIAL
PC2 72-1409	**Small Black Nylon Barbed Connector Kit**		
KIT COMPONENTS:			
PC2 72-1475	Barbed Connector	1/16 to 1/16 in	Black Nylon
PC2 72-1476	Barbed Connector	3/32 to 3/32 in	Black Nylon
PC2 72-1477	Barbed Connector	1/8 to 1/8 in	Black Nylon
PC2 72-1478	Barbed Connector	1/16 to 3/32 in	Black Nylon
PC2 72-1479	Barbed Connector	1/16 to 1/8 in	Black Nylon
PC2 72-1480	Barbed Connector	3/32 to 1/8 in	Black Nylon
PC2 72-1481	L Barbed Connector	1/16 to 1/16 in	Black Nylon
PC2 72-1482	L Barbed Connector	3/32 to 3/32 in	Black Nylon
PC2 72-1483	L Barbed Connector	1/8 to 1/8 in	Black Nylon
PC2 72-1486	L Barbed Connector	3/32 to 1/8 in	Black Nylon
PC2 72-1487	T Barbed Connector	1/16 to 1/16 in	Black Nylon
PC2 72-1488	T Barbed Connector	3/32 to 3/32 in	Black Nylon
PC2 72-1489	T Barbed Connector	1/8 to 1/8 in	Black Nylon
PC2 72-1491	T Barbed Connector	1/16 to 1/8 in	Black Nylon
PC2 72-1492	T Barbed Connector	3/32 to 1/8 in	Black Nylon
PC2 72-1493	Y Barbed Connector	1/16 to 1/16 in	Black Nylon
PC2 72-1494	Y Barbed Connector	3/32 to 3/32 in	Black Nylon
PC2 72-1495	Y Barbed Connector	1/8 to 1/8 in	Black Nylon
PC2 72-1498	Barbed PLUG Connector	1/8 in	Black Nylon
PC2 72-1410	**Small Polypropylene Barbed Connector Kit**		
KIT COMPONENTS:			
PC2 72-1499	Barbed Connector	1/16 to 1/16 in	Polypropylene
PC2 72-1500	Barbed Connector	3/32 to 3/32 in	Polypropylene
PC2 72-1501	Barbed Connector	1/8 to 1/8 in	Polypropylene
PC2 72-1502	Barbed Connector	1/16 to 3/32 in	Polypropylene
PC2 72-1503	Barbed Connector	1/16 to 1/8 in	Polypropylene
PC2 72-1504	Barbed Connector	3/32 to 1/8 in	Polypropylene
PC2 72-1505	L Barbed Connector	1/16 to 1/16 in	Polypropylene
PC2 72-1506	L Barbed Connector	3/32 to 3/32 in	Polypropylene
PC2 72-1507	L Barbed Connector	1/8 to 1/8 in	Polypropylene
PC2 72-1508	L Barbed Connector	1/16 to 3/32 in	Polypropylene
PC2 72-1509	L Barbed Connector	1/16 to 1/8 in	Polypropylene
PC2 72-1510	L Barbed Connector	3/32 to 1/8 in	Polypropylene
PC2 72-1511	T Barbed Connector	1/16 to 1/16 in	Polypropylene
PC2 72-1512	T Barbed Connector	3/32 to 3/32 in	Polypropylene
PC2 72-1513	T Barbed Connector	1/8 to 1/8 in	Polypropylene
PC2 72-1514	T Barbed Connector	1/16 to 3/32 in	Polypropylene
PC2 72-1515	T Barbed Connector	1/16 to 1/8 in	Polypropylene
PC2 72-1516	T Barbed Connector	3/32 to 1/8 in	Polypropylene
PC2 72-1517	Y Barbed Connector	1/16 to 1/16 in	Polypropylene
PC2 72-1518	Y Barbed Connector	3/32 to 3/32 in	Polypropylene
PC2 72-1519	Y Barbed Connector	1/8 to 1/8 in	Polypropylene
PC2 72-1520	Barbed PLUG Connector	1/16 in	Polypropylene
PC2 72-1521	Barbed PLUG Connector	3/32 in	Polypropylene
PC2 72-1522	Barbed PLUG Connector	1/8 in	Polypropylene

Barbed Tubing Connectors (continued)

Barbed Tubing Connector Kits (Continued)

ORDER #	PRODUCT	TUBE ID	MATERIAL
PC2 72-1411	**Small Kynar® Barbed Connector Kit**		
KIT COMPONENTS:			
PC2 72-1523	Barbed Connector	1/16 to 1/16 in	Kynar®
PC2 72-1524	Barbed Connector	3/32 to 3/32 in	Kynar®
PC2 72-1525	Barbed Connector	1/8 to 1/8 in	Kynar®
PC2 72-1526	Barbed Connector	1/16 to 3/32 in	Kynar®
PC2 72-1527	Barbed Connector	1/16 to 1/8 in	Kynar®
PC2 72-1528	Barbed Connector	3/32 to 1/8 in	Kynar®
PC2 72-1530	L Barbed Connector	3/32 to 3/32 in	Kynar®
PC2 72-1531	L Barbed Connector	1/8 to 1/8 in	Kynar®
PC2 72-1533	L Barbed Connector	1/16 to 1/8 in	Kynar®
PC2 72-1535	T Barbed Connector	1/16 to 1/16 in	Kynar®
PC2 72-1536	T Barbed Connector	3/32 to 3/32 in	Kynar®
PC2 72-1537	T Barbed Connector	1/8 to 1/8 in	Kynar®
PC2 72-1539	T Barbed Connector	1/16 to 1/8 in	Kynar®
PC2 72-1540	T Barbed Connector	3/32 to 1/8 in	Kynar®
PC2 72-1541	Y Barbed Connector	1/16 to 1/16 in	Kynar®
PC2 72-1542	Y Barbed Connector	3/32 to 3/32 in	Kynar®
PC2 72-1543	Y Barbed Connector	1/8 to 1/8 in	Kynar®
PC2 72-1412	**Medium Black Nylon Barbed Connector Kit**		
PC2 72-1412	Complete Kit	1/4, 5/16 & 3/8 in	Black Nylon
KIT COMPONENTS:			
PC2 72-1547	Barbed Connector	1/4 to 1/4 in	Black Nylon
PC2 72-1548	Barbed Connector	5/16 to 5/16 in	Black Nylon
PC2 72-1549	Barbed Connector	3/8 to 3/8 in	Black Nylon
PC2 72-1550	Barbed Connector	1/4 to 5/16 in	Black Nylon
PC2 72-1551	Barbed Connector	1/4 to 3/8 in	Black Nylon
PC2 72-1552	Barbed Connector	5/16 to 3/8 in	Black Nylon
PC2 72-1553	L Barbed Connector	1/4 to 1/4 in	Black Nylon
PC2 72-1554	L Barbed Connector	5/16 to 5/16 in	Black Nylon
PC2 72-1555	L Barbed Connector	3/8 to 3/8 in	Black Nylon
PC2 72-1556	T Barbed Connector	1/4 to 1/4 in	Black Nylon
PC2 72-1557	T Barbed Connector	5/16 to 5/16 in	Black Nylon
PC2 72-1558	Y Barbed Connector	3/8 to 3/8 in	Black Nylon
PC2 72-1559	Y Barbed Connector	1/4 to 1/4 in	Black Nylon
PC2 72-1560	Y Barbed Connector	3/8 to 3/8 in	Black Nylon

Barbed Tubing Connector Kits (Continued)

ORDER #	PRODUCT	TUBE ID	MATERIAL
PC2 72-1413	**Medium Polypropylene Barbed Connector Kit**		
KIT COMPONENTS:			
PC2 72-1561	Barbed Connector	1/4 to 1/4 in	Polypropylene
PC2 72-1562	Barbed Connector	5/16 to 5/16 in	Polypropylene
PC2 72-1563	Barbed Connector	3/8 to 3/8 in	Polypropylene
PC2 72-1564	Barbed Connector	1/4 to 5/16 in	Polypropylene
PC2 72-1565	Barbed Connector	1/4 to 3/8 in	Polypropylene
PC2 72-1566	Barbed Connector	5/16 to 3/8 in	Polypropylene
PC2 72-1567	L Barbed Connector	1/4 to 1/4 in	Polypropylene
PC2 72-1568	L Barbed Connector	5/16 to 5/16 in	Polypropylene
PC2 72-1569	L Barbed Connector	3/8 to 3/8 in	Polypropylene
PC2 72-1570	T Barbed Connector	1/4 to 1/4 in	Polypropylene
PC2 72-1571	T Barbed Connector	5/16 to 5/16 in	Polypropylene
PC2 72-1572	T Barbed Connector	3/8 to 3/8 in	Polypropylene
PC2 72-1573	Y Barbed Connector	1/4 to 1/4 in	Polypropylene
PC2 72-1574	Y Barbed Connector	3/8 to 3/8 in	Polypropylene
PC2 72-1414	**Medium Kynar® Barbed Connector Kit**		
KIT COMPONENTS:			
PC2 72-1575	Barbed Connector	1/4 to 1/4 in	Kynar®
PC2 72-1576	Barbed Connector	5/16 to 5/16 in	Kynar®
PC2 72-1577	Barbed Connector	3/8 to 3/8 in	Kynar®
PC2 72-1578	Barbed Connector	1/4 to 5/16 in	Kynar®
PC2 72-1579	Barbed Connector	1/4 to 3/8 in	Kynar®
PC2 72-1580	Barbed Connector	5/16 to 3/8 in	Kynar®
PC2 72-1581	L Barbed Connector	1/4 to 1/4 in	Kynar®
PC2 72-1582	L Barbed Connector	5/16 to 5/16 in	Kynar®
PC2 72-1583	L Barbed Connector	3/8 to 3/8 in	Kynar®
PC2 72-1584	T Barbed Connector	1/4 to 1/4 in	Kynar®
PC2 72-1585	T Barbed Connector	5/16 to 5/16 in	Kynar®
PC2 72-1586	T Barbed Connector	3/8 to 3/8 in	Kynar®
PC2 72-1587	Y Barbed Connector	1/4 to 1/4 in	Kynar®
PC2 72-1588	Y Barbed Connector	3/8 to 3/8 in	Kynar®

Barbed Tubing Connectors (continued)


PC2 72-1409 Small Kit


PC2 72-1412 Medium Kit

Barbed Tubing Connector Kits (Continued)

ORDER #	PRODUCT	TUBE ID	MATERIAL
PC2 72-1415	**Large Black Nylon Barbed Connector Kit**		
KIT COMPONENTS:			
PC2 72-1589	Barbed Connector	1/2 to 1/2 in	Black Nylon
PC2 72-1590	Barbed Connector	5/8 to 5/8 in	Black Nylon
PC2 72-1591	L Barbed Connector	1/2 to 1/2 in	Black Nylon
PC2 72-1592	L Barbed Connector	5/8 to 5/8 in	Black Nylon
PC2 72-1593	T Barbed Connector	1/2 to 1/2 in	Black Nylon
PC2 72-1594	T Barbed Connector	5/8 to 5/8 in	Black Nylon
PC2 72-1595	Y Barbed Connector	1/2 to 5/8 in	Black Nylon
PC2 72-1596	Y Barbed Connector	1/2 to 1/2 in	Black Nylon
PC2 72-1416	**Large Polypropylene Barbed Connector Kit**		
KIT COMPONENTS:			
PC2 72-1597	Barbed Connector	1/2 to 1/2 in	Polypropylene
PC2 72-1598	Barbed Connector	5/8 to 5/8 in	Polypropylene
PC2 72-1599	L Barbed Connector	1/2 to 1/2 in	Polypropylene
PC2 72-1600	L Barbed Connector	5/8 to 5/8 in	Polypropylene
PC2 72-1601	T Barbed Connector	1/2 to 1/2 in	Polypropylene
PC2 72-1602	T Barbed Connector	5/8 to 5/8 in	Polypropylene
PC2 72-1603	Y Barbed Connector	1/2 to 5/8 in	Polypropylene
PC2 72-1604	Y Barbed Connector	1/2 to 1/2 in	Polypropylene
PC2 72-1417	**Large Kynar® Barbed Connector Kit**		
KIT COMPONENTS:			
PC2 72-1605	Barbed Connector	1/2 to 1/2 in	Kynar®
PC2 72-1606	Barbed Connector	5/8 to 5/8 in	Kynar®
PC2 72-1607	L Barbed Connector	1/2 to 1/2 in	Kynar®
PC2 72-1608	L Barbed Connector	5/8 to 5/8 in	Kynar®
PC2 72-1609	T Barbed Connector	1/2 to 1/2 in	Kynar®
PC2 72-1610	T Barbed Connector	5/8 to 5/8 in	Kynar®
PC2 72-1611	Y Barbed Connector	1/2 to 5/8 in	Kynar®
PC2 72-1612	Y Barbed Connector	1/2 to 1/2 in	Kynar®


PC2 72-1416 Large Kit

Barbed Tubing Connectors (continued)

Luer to Tube Kits


PC2 72-1406
Luer Connector Kit, White Nylon

The Luer Connector 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, polypropylene and Kynar®, a chemically resistant autoclavable plastic. Each kit is supplied in a convenient box. All kit components are also sold separately.

The Male Luer Taper kits contain a selection of Male Luer Taper fittings to barbed connectors as well as Male Luer Taper to Male Luer Taper fittings. These kits also contain color coded rotating Luer lock rings that securely snap onto the Male Luer Taper side of each connector. These kits are available in white nylon, polypropylene and Kynar®, a chemically resistant autoclavable plastic. Each kit is supplied in a convenient box. All kit components are also sold separately.

Luer to Tube Kits

ORDER #	PRODUCT	TUBE ID	MATERIAL
PC2 72-1406	White Nylon Luer Connector Kit		
KIT COMPONENTS:			
PC2 72-1418	Barbed Connector	FLL to 1/16 in	White Nylon
PC2 72-1419	Barbed Connector	FLL to 3/32 in	White Nylon
PC2 72-1420	Barbed Connector	FLL to 1/8 in	White Nylon
PC2 72-1421	Barbed Connector	FLL to 5/32 in	White Nylon
PC2 72-1422	Barbed Connector	FLL to 3/16 in	White Nylon
PC2 72-1423	Barbed Connector	FLL to 1/4 in	White Nylon
PC2 72-1424	Barbed Connector	FLL to 1/16 in	White Nylon
PC2 72-1425	Barbed Connector	FLL to 3/32 in	White Nylon
PC2 72-1426	Barbed Connector	FLL to 1/8 in	White Nylon
PC2 72-1427	Barbed Connector	FLL to 5/32 in	White Nylon
PC2 72-1428	Barbed Connector	FLL to 3/16 in	White Nylon
PC2 72-1429	Barbed Connector	FLL to 1/4 in	White Nylon
PC2 72-1430	Cap Connector	MLL	White Nylon
PC2 72-1431	Cap Connector	FLL	White Nylon
PC2 72-2735	Coupler with Threaded FLL Connection	FLL to MLL	White Nylon
PC2 72-1433	Connector	MLT to MLT	White Nylon
PC2 72-1434	Connector	FLL to FLL	White Nylon
PC2 72-1435	Elbow Connector	FLL to FLL	White Nylon
PC2 72-1436	T Connector	3-Way FLL	White Nylon

Luer to Tube Kits (Continued)

ORDER #	PRODUCT	TUBE ID	MATERIAL
PC2 72-1407	Polypropylene Luer Connector Kit		
KIT COMPONENTS:			
PC2 72-1437	Barbed Connector	FLL to 1/16	Polypropylene
PC2 72-1438	Barbed Connector	FLL to 3/32	Polypropylene
PC2 72-1439	Barbed Connector	FLL to 1/8	Polypropylene
PC2 72-1440	Barbed Connector	FLL to 5/32	Polypropylene
PC2 72-1441	Barbed Connector	FLL to 3/16	Polypropylene
PC2 72-1442	Barbed Connector	FLL to 1/4	Polypropylene
PC2 72-1443	Barbed Connector	MLL to 1/16	Polypropylene
PC2 72-1444	Barbed Connector	MLL to 3/32	Polypropylene
PC2 72-1445	Barbed Connector	MLL to 1/8	Polypropylene
PC2 72-1446	Barbed Connector	MLL to 5/32	Polypropylene
PC2 72-1447	Barbed Connector	MLL to 3/16	Polypropylene
PC2 72-1448	Barbed Connector	MLL to 1/4	Polypropylene
PC2 72-1449	Cap Connector	MLL	Polypropylene
PC2 72-1450	Cap Connector	FLL	Polypropylene
PC2 72-2736	Coupler w/ Threaded FLL Connection	FLL to MLL	Polypropylene
PC2 72-1452	Connector	MLT to MLT	Polypropylene
PC2 72-1453	Connector	FLL to FLL	Polypropylene
PC2 72-1454	Elbow Connector	FLL to FLL	Polypropylene
PC2 72-1455	T Connector	3-Way FLL	Polypropylene
PC2 72-1408	Kynar® Luer Connector Kit		
KIT COMPONENTS:			
PC2 72-1456	Barbed Connector	FLL to 1/16	Kynar®
PC2 72-1457	Barbed Connector	FLL to 3/32	Kynar®
PC2 72-1458	Barbed Connector	FLL to 1/8	Kynar®
PC2 72-1462	Barbed Connector	MLL to 1/16	Kynar®
PC2 72-1464	Barbed Connector	MLL to 1/8	Kynar®
PC2 72-1465	Barbed Connector	MLL to 5/32	Kynar®
PC2 72-1466	Barbed Connector	MLL to 3/16	Kynar®
PC2 72-1467	Barbed Connector	MLL to 1/4	Kynar®
PC2 72-1468	Cap Connector	MLL	Kynar®
PC2 72-1469	Cap Connector	FLL	Kynar®
PC2 72-2737	Coupler w/Threaded FLL Connection	FLL to MLL	Kynar®
PC2 72-1471	Connector	MLT to MLT	Kynar®
PC2 72-1472	Connector	FLL to FLL	Kynar®

Barbed Tubing Connectors (continued)

Luer to Tube Kits (Continued)

ORDER #	PRODUCT	TUBE ID	MATERIAL
PC2 72-2738	White Nylon Male Luer Taper Kit		
KIT COMPONENTS:			
PC2 72-2731	Snap Luer Lock Ring	Male	Red Nylon
PC2 72-2732	Snap Luer Lock Ring	Male	Green Nylon
PC2 72-2733	Snap Luer Lock Ring	Male	Polypropylene
PC2 72-2695	Barbed Connector	MLT to 1/16 in	White Nylon
PC2 72-2696	Barbed Connector	MLT to 3/32 in	White Nylon
PC2 72-2741	Luer Coupler	Male	White Nylon
PC2 72-2697	Barbed Connector	MLT to 1/8 in	White Nylon
PC2 72-2698	Barbed Connector	MLT to 5/32 in	White Nylon
PC2 72-2699	Barbed Connector	MLT to 3/16 in	White Nylon
PC2 72-2700	Barbed Connector	MLT to 1/4 in	White Nylon
PC2 72-2701	Barbed Connector	MLT to 1/16 in	White Nylon
PC2 72-2747	T-Connector	FLL/MLT/MLT	White Nylon
PC2 72-2702	Barbed Connector	MLT to 3/32 in	White Nylon
PC2 72-2703	Barbed Connector	MLT to 1/8 in	White Nylon
PC2 72-2704	Barbed Connector	MLT to 5/32 in	White Nylon
PC2 72-2705	Barbed Connector	MLT to 1/8 in	White Nylon
PC2 72-2706	Barbed Connector	MLT to 1/4 in	White Nylon
PC2 72-2744	T-Connector	FLL/MLT/FLL	White Nylon
PC2 72-2739	Polypropylene Male Luer Taper Kit		
KIT COMPONENTS:			
PC2 72-2731	Snap Luer Lock Ring	Male	Red Nylon
PC2 72-2732	Snap Luer Lock Ring	Male	Green Nylon
PC2 72-2733	Snap Luer Lock Ring	Male	Polypropylene
PC2 72-2707	Barbed Connector	MLT to 1/16 in	Polypropylene
PC2 72-2708	Barbed Connector	MLT to 3/32 in	Polypropylene
PC2 72-2742	Luer Coupler	Male	Polypropylene
PC2 72-2709	Barbed Connector	MLT to 1/8 in	Polypropylene
PC2 72-2710	Barbed Connector	MLT to 5/32 in	Polypropylene
PC2 72-2711	Barbed Connector	MLT to 3/16 in	Polypropylene
PC2 72-2712	Barbed Connector	MLT to 1/4 in	Polypropylene
PC2 72-2713	Barbed Connector	MLT to 1/16 in	Polypropylene
PC2 72-2748	T-Connector	FLL/MLT/MLT	Polypropylene
PC2 72-2714	Barbed Connector	MLT to 3/32 in	Polypropylene
PC2 72-2715	Barbed Connector	MLT to 1/8 in	Polypropylene
PC2 72-2716	Barbed Connector	MLT to 5/32 in	Polypropylene
PC2 72-2717	Barbed Connector	MLT to 3/16 in	Polypropylene
PC2 72-2718	Barbed Connector	MLT to 1/4 in	Polypropylene
PC2 72-2745	T-Connector	FLL/MLT/FLL	Polypropylene

PC2 72-1406
Luer Connector Kit, White Nylon

Luer to Tube Kits (Continued)

ORDER #	PRODUCT	TUBE ID	MATERIAL
PC2 72-2740	Polycarbonate Male Luer Taper Kit		
KIT COMPONENTS:			
PC2 72-2731	Snap Luer Lock Ring	Male	Red Nylon
PC2 72-2732	Snap Luer Lock Ring	Male	Green Nylon
PC2 72-2734	Snap Luer Lock Ring	Male	Polycarbonate
PC2 72-2719	Barbed Connector	MLT to 1/16 in	Polycarbonate
PC2 72-2720	Barbed Connector	MLT to 3/32 in	Polycarbonate
PC2 72-2743	Luer Coupler	Male	Polycarbonate
PC2 72-2721	Barbed Connector	MLT to 1/8 in	Polycarbonate
PC2 72-2722	Barbed Connector	MLT to 5/32 in	Polycarbonate
PC2 72-2723	Barbed Connector	MLT to 3/16 in	Polycarbonate
PC2 72-2724	Barbed Connector	MLT to 1/4 in	Polycarbonate
PC2 72-2725	Barbed Connector	MLT to 1/16 in	Polycarbonate
PC2 72-2749	T-Connector	FLL/MLT/MLT	Polycarbonate
PC2 72-2726	Barbed Connector	MLT to 3/32 in	Polycarbonate
PC2 72-2727	Barbed Connector	MLT to 1/8 in	Polycarbonate
PC2 72-2728	Barbed Connector	MLT to 5/32 in	Polycarbonate
PC2 72-2729	Barbed Connector	MLT to 3/16 in	Polycarbonate
PC2 72-2730	Barbed Connector	MLT to 1/4 in	Polycarbonate
PC2 72-2746	T-Connector	FLL/MLT/FLL	Polycarbonate

Kits and Valves

Flow Control Pinch Valves

The Flow Control Pinch Valves work with tubing from 5/32 inch OD to 3/8 inch OD. The micrometer dial offers easy resetting of clamping distance. These valves are made of Delrin® and Acetal.

Order #	Clamp Size	Tubing Clamp Range
PC2 72-2694	Small	5/32 to 1/4 in OD Tubing
PC2 72-8140	Medium	5/32 to 3/8 in OD Tubing

Tubing Clamp Kits

The clamps in the Tubing Clamp Kit 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. This kit is supplied in a convenient box containing 5 of each clamp size.

Order #	Product
PC2 72-1668	Tubing Clamp Kit

Kits and Valves (continued)

Tubing Manifold Kit

The Tubing Manifold Kit contains several varieties of tubing manifolds for tube to tube connections. Many are compatible with MLT (male Luer taper) fittings. This kit is supplied in a convenient box. All kit components are also sold separately.

Tubing Manifold Kit

ORDER #	PRODUCT
PC2 72-7481	Tubing Manifold Kit
KIT COMPONENTS:	
PC2 72-2665	Multiport Adapter 3 to 1 Modified Y Connector, 0.214" OD ports
PC2 72-2666	3-Way Y Connector FLL/FLL/FLL/MLL (ROTATING)
PC2 72-2672	Multiport Adapter 3 to 1 Modified Y Connector, 0.161" ID ports
PC2 72-2673	Y Connector FLL/FLL/MLL (Rotating)
PC2 72-2668	Multiport Adapter 3 to 1 Parallel Tube Connector, 0.154" ID x 0.215" OD ports
PC2 72-2675	Multiport Adapter 3 to 1 Parallel Tube Connector, 0.267" ID x 8.6mm OD ports
PC2 72-2667	Multiport Adapter 3 to 1 Parallel Tube Connector, 0.142" to 0.158" ID ports
PC2 72-7479	Multiport Adapter 2 to 1 Parallel Tube Connector, 0.142" to 0.158" ID ports
PC2 72-7480	Multiport Adapter 2 to 1 Parallel Tube Connector, 0.161" ID ports
PC2 72-2677	Multiport Adapter 6 to 1 Parallel Tube Connector, 0.161" ID ports

Luer Stopcock Kit

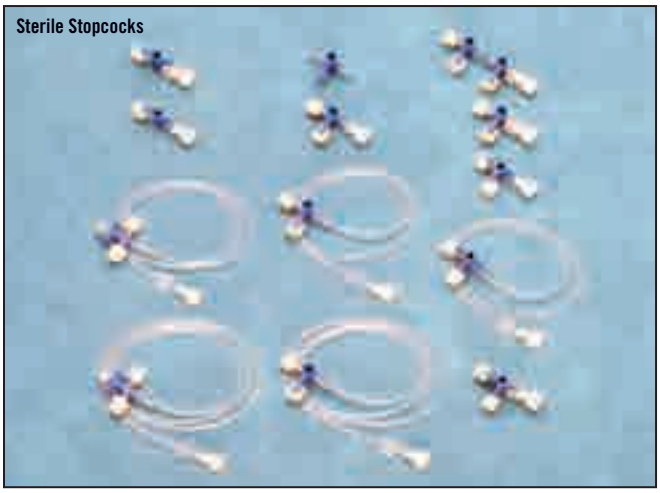
The Luer Stopcock Kit includes a collection of 1-, 3- and 4-way stopcocks. Fittings include MLL (male Luer lock), FLL (female Luer lock) and Male Luer Slip. Some stopcocks have high pressure capabilities. This kit is supplied in a convenient box. All kit components are also sold separately.

Luer Stopcock Kit

ORDER #	PRODUCT
PC2 72-1664	Luer Stopcock Kit
KIT COMPONENTS:	
PC2 72-8327	One Way Stopcock (200 psi), FLL/Male Luer Slip
PC2 72-2647	One Way Stopcock (500 psi), FLL/MLL (Non-Rotating)
PC2 72-2648	3-Way Stopcock (1050 psi), FLL/FLL/MLL (Rotating)
PC2 72-2649	3-Way Stopcock (200 psi), FLL/FLL/MLL (Non-Rotating)
PC2 72-2650	One Way Stopcock (1050 psi), FLL/MLL (Non-Rotating)
PC2 72-8326	One Way Stopcock (200 psi), FLL/MLL (Rotating)
PC2 72-8328	4-Way Stopcock, FLL/FLL/Male Luer Slip
PC2 72-2693	3-Way Stopcock (200 psi), FLL/FLL/Male Luer Slip
PC2 72-2654	4-Way Stopcock, FLL/FLL/MLL (Rotating)
PC2 72-2655	One Way Stopcock (1050 psi), FLL/MLL (Rotating)
PC2 72-2656	3-Way Stopcock, FLL/FLL/MLL (Rotating)
PC2 72-2657	One Way Stopcock (500 psi), FLL/MLL (Rotating)
PC2 72-2658	3-Way Stopcock (1050 psi), FLL/FLL/MLL (Non-Rotating)
PC2 72-2659	3-Way Stopcock, FLL/FLL/FLL
PC2 72-2660	3-Way Stopcock (500 psi), FLL/FLL/MLL (Non-Rotating)
PC2 72-2661	4-Way Stopcock, FLL/FLL/MLL (Rotating)
PC2 72-2662	3-Way Stopcock (200 psi), FLL/FLL/MLL (Rotating)
PC2 72-2663	One Way Stopcock, FLL/MLL (Rotating)
PC2 72-9473	3-Way Stopcock, FLL/FLL/MLL (Non-Rotating)

Kits and Valves (continued)

Sterile Stopcocks



KEY FEATURES

- 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.

Order #	Product
PC2 72-2626	1-Way MLL to FLL Stopcock, with Port Covers
PC2 72-2627	1-Way FLL to MLT Stopcock, with Port Covers
PC2 72-2628	Multipath* Stopcock, 2 x FLT, Injection Site, 20 inch Ext. Tube
PC2 72-2630	3-Way Stopcock, FLL to MLT, No Port Covers
PC2 72-2631	3-Way Stopcock, FLL to MLT with Port Covers
PC2 72-2632	3-Way Stopcock FLL to 20 inch Ext. Tube Set
PC2 72-2633	3-Way Stopcock FLL to 33 inch Ext. Tube Set
PC2 72-2634	Double 3-Way Stopcock, FLL to MLL with Port Covers
PC2 72-2635	3-Way, FLL to MLL with Port Covers
PC2 72-2637	4-Way, FLL to 20 inch Ext. Tube Set
PC2 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.*

Spring-Clip Stopcocks

KEY FEATURES

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

Spring-Clip Stopcocks			
ORDER #	**B-D SPRING CLIP EQUIV.**	**TYPE**	**DESCRIPTION**
PC2 59-8121	3138	3-Way	FLL to MLT, Right Side - FLL
PC2 59-8122	3161	3-Way	FLL to MLT, Right Side - Hose Barb[3]
PC2 59-8123	3150	3-Way	FLL to MLL, Right Side - Hose Barb[3]
PC2 59-8124	3156	3-Way	FLL to MLL, Right Side - FLL
PC2 59-8125[1]	3192	3-Way	FLL to MLT, Left Side - FLL
PC2 59-8126[2]	3135	1-Way	FLL to MLT
PC2 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

Micro Tubing and Connector Kit, Syringe Needles

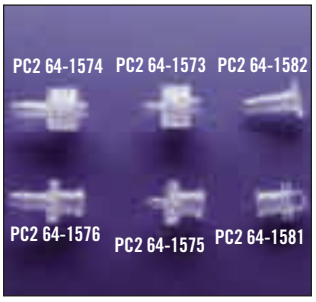
Parts and Accessories

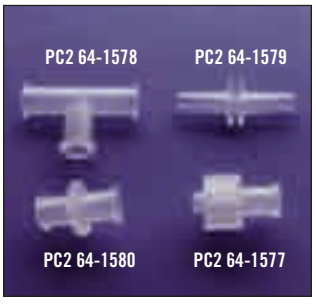
The kit is comprised of barbed and Luer fittings, blunt end needles, and an assortment of PE and C-Flex tubing. All barbed and Luer fittings are made from polypropylene and include tube to tube, reducing, Y-, T-, Luer-to-Luer, and Luer-to-barb adapters.

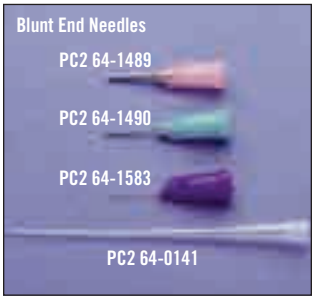
Comes in a convenient plastic storage box.

Order #	Model	Product
PC2 64-1565	KIT-1	Fitting and Tubing Kit

Components listed at right are included in the tubing and connector kit. Components also sold separately.



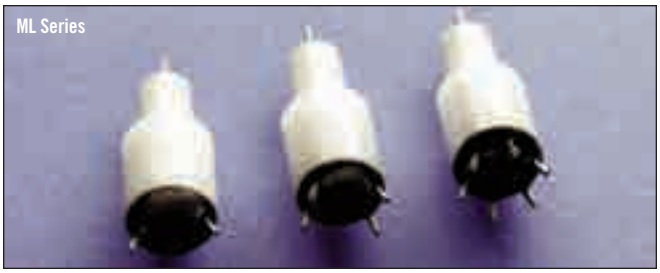


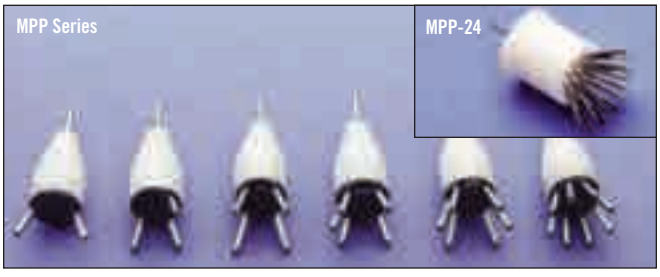


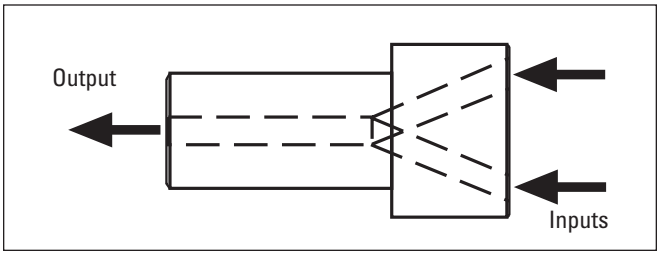
Order #	Product
PC2 64-1566	Tube Fitting Barb 1/8" to 1/16", pkg. of 10
PC2 64-1567	Tube Fitting Barb 1/16" to 1/16", pkg. of 10
PC2 64-1568	Tube Fitting Barb 1/8" to 1/8", pkg. of 10
PC2 64-1569	Tube Fitting Tee Barb 1/16", pkg. of 10
PC2 64-1570	Tube Fitting Tee Barb 1/8", pkg. of 10
PC2 64-1571	Tube Fitting Y Barb 1/16", pkg. of 10
PC2 64-1572	Tube Fitting Y Barb 1/8", pkg. of 10
PC2 64-1573	Tube Fitting Barb 1/16" to Luer Male, pkg. of 10
PC2 64-1574	Tube Fitting Barb 1/8" to Luer Male, pkg. of 10
PC2 64-1575	Tube Fitting Barb 1/16" to Luer Female, pkg. of 10
PC2 64-1576	Tube Fitting Barb 1/8" to Luer Female, pkg. of 10
PC2 64-1577	Tube Fitting Luer Male to Luer Female, pkg. of 10
PC2 64-1578	Tube Fitting Luer Tee Female, pkg. of 10
PC2 64-1579	Tube Fitting Luer Male to Luer Male, pkg. of 10
PC2 64-1580	Tube Fitting Luer Female to Luer Female, pkg. of 10
PC2 64-1581	Tube Fitting Luer Female Plug, pkg. of 10
PC2 64-1582	Tube Fitting Luer Male Plug, pkg. of 10
PC2 64-0141	LPE-50, Luer to PE-50 tubing adapter, pkg. of 8
PC2 64-0166	CFL-6, C-Flex tubing (1/32" ID x 6 ft) 3/32 OD mm, 6 ft
BLUNT NEEDLE PLASTIC HUB	
PC2 64-1489	SN-18, 18G, 0.5", pkg. of 12
PC2 64-1490	SN-23, 23G, 0.5", pkg. of 12
PC2 64-1583	SN-30, 30G, 0.5", pkg. of 12
PC2 64-1869	SN-20, 20G, 0.5", Pkg. of 12
POLYETHYLENE TUBING	
PC2 64-0750	PE-10/10., 0.28 ID x 0.61 OD mm, 3.1 m (10 ft) long
PC2 64-0752	PE-50/10., 0.58 ID x 0.97 OD mm, 3.1 (10 ft) long
PC2 64-0754	PE-90/10., 0.86 ID x 1.27 OD mm, 3.1 m (10 ft) long
PC2 64-0755	PE-160/10., 1.14 ID x 1.57 OD mm, 3.1 m (10 ft) long

ML, MM, MP and MPP Series

Manifolds and Flow Control Hardware







ML, MM, MP and MPP Series Material and Size Chart

	ML Series	MM Series	MP Series	MPP Series
MATERIAL	Delrin™	Delrin™	PTFE	Delrin™
LARGE DIAMETER	8.0 mm	8.0 mm	9.4 mm	9.4 mm
SMALL DIAMETER	4.7 mm	4.7 mm	6.3 mm	4.7 mm
BODY LENGTH	18 mm	18 mm	22 mm	21 mm
INPUT TUBING	PE-50	PE-50	PE-160	PE-160
OUTPUT TUBING	PE-50	PE-10	PE-160	PE-160

Multi-in or multi-out manifolds for fluid management

Harvard Apparatus manifolds can be used in any application where from 2 to 8 perfusion lines are required to be connected to a chamber or other device. Manifold inputs converge to the common output with minimum dead space. Designed for use with polyethylene (PE) tubing, manifolds can be used with any other tubing of similar dimensions. When connected to a chamber via a short length of tubing, very rapid solution changes are possible.

ML and MM Series

These miniature manifolds are useful for applications involving small volumes or slow flow rates. Small diameter tubing is used with these models; PE-50 tubing for the input ports, and PE-10 or PE-50 tubing for the MM or ML series output ports, respectively.

MP Series

MP series manifolds are recommended low pressure (< 25 psi) systems. Input and output tubing are inserted with a friction fit. Manifolds should be ordered with inputs to match the number of solutions to be connected. Pin plugs to block unused inputs are also supplied. MP series manifolds are used with PE-160 tubing.

MPP Series

These manifolds are suitable for systems in which solutions are pumped or at pressures < 25 psi. Input and output ports are 18 gauge stainless steel hypodermic tubing. PE-160 tubing slides over these ports to make a snug fit.

Order #	Model	Product
PC2 64-0200	ML-2	Miniature Manifold, 2 ports
PC2 64-0201	ML-4	Miniature Manifold, 4 ports
PC2 64-0202	ML-6	Miniature Manifold, 6 ports
PC2 64-0199	ML-8	Miniature Manifold, 8 ports
PC2 64-0203	MM-2	Miniature Manifold, 2 ports
PC2 64-0204	MM-4	Miniature Manifold, 4 ports
PC2 64-0205	MM-6	Miniature Manifold, 6 ports
PC2 64-0206	MP-2	MP Manifold, 2 ports
PC2 64-0207	MP-3	MP Manifold, 3 ports
PC2 64-0208	MP-4	MP Manifold, 4 ports
PC2 64-0209	MP-5	MP Manifold, 5 ports
PC2 64-0210	MP-6	MP Manifold, 6 ports
PC2 64-0211	MP-8	MP Manifold, 8 ports
PC2 64-0212	MPP-2	MPP Manifold, 2 ports
PC2 64-0213	MPP-3	MPP Manifold, 3 ports
PC2 64-0214	MPP-4	MPP Manifold, 4 ports
PC2 64-0215	MPP-5	MPP Manifold, 5 ports
PC2 64-0216	MPP-6	MPP Manifold, 6 ports
PC2 64-0217	MPP-8	MPP Manifold, 8 ports
PC2 64-0339	MPP-24	MPP Manifold, 24 ports

All manifolds can be easily disassembled for cleaning.

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 material
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 material being pumped
7. The temperature of the material being pumped

		NORMAL PRESSURE 0 to 30 psi (0 to 2 bar)	HIGH FORCE 31 to 150 psi (2.1 to 10.2 bar)	EXTREME 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	High viscosity 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 = 1500 psi			
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 and surface areas for a variety of syringes can be found in the table on page 120. 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 in2 X 2) = 38.81 PSI (2.68 bars).

Pump Average Pressure[A] (PSI)[B]

Syringe Size	Syringe Diameter (mm)	Pump 11 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
10 µl	0.5	>1000	>1000	>1000	>1000	–	>1000
50 µl	1	>1000	>1000	>1000	>1000	–	>1000
1 ml	5	526	>1000	>1000	>1000	–	>1000
5 ml	10	131	386	468	394	–	1438
10 ml	15	58	172	208	175	–	639
50 ml	25	21	62	75	63	569	230
Force (lbs)		16	47	57	48	433	200
See page		29	30	31	32	35	35

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.

PHD 22/2000 HPSI Flow Rates

Syringe Size	Diameter **	Minimum	Maximum
20 ml	19.13 mm	1.5 µl/hr	20 ml/min
50 ml	28.60 mm	3.4 µl/hr	46 ml/min
100 ml	34.90 mm	5.0 µl/hr	68 ml/min
200 ml	44.75 mm	8.2 µl/hr	112 ml/min

** The Rates listed are for single stainless steel syringe*

***Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

PHD ULTRA™ HPSI & XF Flow Rates

Syringe Size	Syringe ID **	Minimum Rate	Maximum Rate
20 ml	19.130 mm	50.7884 nl/min	26.3709 ml/min
30 ml	21.590 mm	64.6904 nl/min	33.5893 ml/min
50 ml	28.600 mm	113.519 nl/min	58.9423 ml/min
100 ml	34.900 mm	169.038 nl/min	87.7700 ml/min
130 ml	37.948 mm	199.854 nl/min	103.770 ml/min
200 ml	44.755 mm	277.983 nl/min	144.337 ml/min

** The Rates listed are for single stainless steel syringe*

***Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

Syringe Pump Pressure and Flow Rate

Minimum/Maximum Flow Rates By Pump and Syringe Size

Pump 11 Elite Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	1.26 pl/min	1.326 µl/min
1 µl	0.146 mm	2.52 pl/min	2.654 µl/min
2 µl	0.206 mm	5.10 pl/min	5.304 µl/min
5 µl	0.343 mm	14.160 pl/min	14.710 µl/min
10 µl	0.485 mm	28.260 pl/min	29.400 µl/min
25 µl	0.729 mm	63.960 pl/min	66.430 µl/min
50 µl	1.030 mm	127.700 pl/min	132.600 µl/min
100 µl	1.457 mm	255.500 pl/min	265.400 µl/min
250 µl	2.304 mm	638.900 pl/min	663.500 µl/min
500 µl	3.256 mm	1.276 nl/min	1.325 ml/min
1000 µl	4.608 mm	2.556 nl/min	2.654 ml/min
1 ml	4.699 mm	2.658 nl/min	2.760 ml/min
3 ml	8.585 mm	8.871 nl/min	9.213 ml/min
5 ml	11.99 mm	17.300 nl/min	17.970 ml/min
10 ml	14.43 mm	25.050 nl/min	26.020 ml/min
20 ml	19.05 mm	43.680 nl/min	45.360 ml/min
30 ml	21.59 mm	56.110 nl/min	58.270 ml/min
50 ml	26.59 mm	85.130 nl/min	88.400 ml/min
60 ml	26.59 mm	85.130 nl/min	88.400 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

NanoCool Injector Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	3.66 pl/min	1.909 µl/min
1 µl	0.146 mm	7.32 pl/min	3.819 µl/min
2 µl	0.206 mm	14.70 pl/min	7.635 µl/min
5 µl	0.343 mm	40.74 pl/min	21.17 µl/min
10 µl	0.485 mm	81.48 pl/min	42.32 µl/min
25 µl	0.729 mm	184.1 pl/min	95.62 µl/min
50 µl	1.030 mm	367.6 pl/min	190.9 µl/min
100 µl	1.457 mm	735.6 pl/min	381.9 µl/min
250 µl	2.304 mm	1.839 nl/min	955.1 µl/min
500 µl	3.256 mm	3.677 nl/min	1.907 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

Pump 11 Plus Flow Rates

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.10 mm	0.0001 µl/min	0.0003 ml/min
1 µl	0.15 mm	0.0001 µl/min	0.0008 ml/min
2 µl	0.21 mm	0.0002 µl/min	0.0016 ml/min
5 µl	0.33 mm	0.0003 µl/min	0.0040 ml/min
10 µl	0.46 mm	0.0005 µl/min	0.0078 ml/min
25 µl	0.73 mm	0.0013 µl/min	0.0198 ml/min
50 µl	1.03 mm	0.0025 µl/min	0.0395 ml/min
100 µl	1.46 mm	0.0049 µl/min	0.0794 ml/min
250 µl	2.30 mm	0.0121 µl/min	0.1970 ml/min
500 µl	3.26 mm	0.0242 µl/min	0.3959 ml/min
1 ml	5.00 mm	0.0484 µl/min	0.7918 ml/min
2.5 ml	7.28 to 9.6 mm	0.1206 µl/min	1.974 ml/min
3 ml	8.66 to 9.0 mm	0.1706 µl/min	2.794 ml/min
5 ml	10.3 to 13.0 mm	0.2413 µl/min	3.952 ml/min
10 ml	14.57 to 15.9 mm	0.4828 µl/min	7.909 ml/min
20 ml	19.13 to 20.05 mm	0.9142 µl/min	14.97 ml/min
30 ml	21.7 to 23.2 mm	1.214 µl/min	19.88 ml/min
50 ml	26.7 to 32.6 mm	1.622 µl/min	26.56 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

Pump 11 Elite Nanomite & PHD ULTRA™ Nanomite Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	3.66 pl/min	1.909 µl/min
1 µl	0.146 mm	7.32 pl/min	3.819 µl/min
2 µl	0.206 mm	14.70 pl/min	7.635 µl/min
5 µl	0.343 mm	40.74 pl/min	21.17 µl/min
10 µl	0.485 mm	81.48 pl/min	42.32 µl/min
25 µl	0.729 mm	184.1 pl/min	95.62 µl/min
50 µl	1.030 mm	367.6 pl/min	190.9 µl/min
100 µl	1.457 mm	735.6 pl/min	381.9 µl/min
250 µl	2.304 mm	1.839 nl/min	955.1 µl/min
500 µl	3.256 mm	3.677 nl/min	1.907 ml/min
1000 µl	4.608 mm	7.358 nl/min	3.820 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

Syringe Pump Pressure and Flow Rate (continued)

Minimum/Maximum Flow Rates By Pump and Syringe Size

Pico Plus Elite Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	0.54 pl/min	596.5 nl/min
1 µl	0.1457 mm	1.14 pl/min	1.194 µl/min
2 µl	0.206 mm	2.28 pl/min	2.386 µl/min
5 µl	0.343 mm	6.36 pl/min	6.615 µl/min
10 µl	0.485 mm	12.72 pl/min	13.230 µl/min
25 µl	0.729 mm	28.74 pl/min	29.880 µl/min
50 µl	1.030 mm	57.42 pl/min	59.650 µl/min
100 µl	1.457 mm	114.9 pl/min	119.4 µl/min
250 µl	2.304 mm	287.4 pl/min	298.5 µl/min
500 µl	3.256 mm	574.0 pl/min	596.1 µl/min
1000 µl	4.608 mm	1.150 nl/min	1.194 ml/min
1 ml	4.699 mm	1.196 nl/min	1.241 ml/min
3 ml	8.585 mm	3.990 nl/min	4.144 ml/min
5 ml	11.989 mm	7.782 nl/min	8.082 ml/min
10 ml	14.430 mm	11.270 nl/min	11.700 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

Pump 22 and Physio 22 Flow Rates

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.10 mm	0.002 µl/hr	23.8 µl/hr
1 µl	0.15 mm	0.003 µl/hr	47.8 µl/hr
2 µl	0.21 mm	0.006 µl/hr	95.2 µl/hr
5 µl	0.33 mm	0.015 µl/hr	238.0 µl/hr
10 µl	0.46 mm	0.029 µl/hr	474.0 µl/hr
25 µl	0.73 mm	0.073 µl/hr	1193.0 µl/hr
50 µl	1.03 mm	0.002 µl/min	39.7 µl/min
100 µl	1.46 mm	0.005 µl/min	79.7 µl/min
250 µl	2.30 mm	0.012 µl/min	197.8 µl/min
500 µl	3.26 mm	0.024 µl/min	397.0 µl/min
1000 µl	4.61 mm	0.048 µl/min	795.0 µl/min
1 ml	5.00 mm	0.049 µl/min	805.0 µl/min
2 ml	9.00 mm	0.011 ml/hr	186.6 ml/hr
2.5 ml	7.28 to 9.6 mm	0.010 ml/hr	168.2 ml/hr
3 ml	8.66 to 9.0 mm	0.011 ml/hr	181.4 ml/hr
5 ml	10.3 to 13.0 mm	0.019 ml/hr	317.0 ml/hr
10 ml	14.57 to 15.9 mm	0.028 ml/hr	461.0 ml/hr
20 ml	19.13 to 20.05 mm	0.050 ml/hr	821.0 ml/hr
30 ml	21.7 to 23.2 mm	0.074 ml/hr	1208.8 ml/hr
50 ml	26.7 to 32.6 mm	0.002 ml/min	28.4 ml/min
100 ml	34.9 to 35.7 mm	0.003 ml/min	47.6 ml/min
140 ml	38.40 mm	0.004 ml/min	55.1 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

Syringe Pump Pressure and Flow Rate (continued)

Minimum/Maximum Flow Rates By Pump and Syringe Size

Pump 33 Flow Rates

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	0.0004 µl/hr	0.79 µl/min
1 µl	0.1457 mm	0.0008 µl/hr	1.58 µl/min
2 µl	0.206 mm	0.0015 µl/hr	3.1 µl/min
5 µl	0.3257 mm	0.0037 µl/hr	7.93 µl/min
10 µl	0.46 mm	0.0073 µl/hr	15.829 µl/min
25 µl	0.73 mm	0.0183 µl/hr	39.756 µl/min
50 µl	1.03 mm	0.0365 µl/hr	79.519 µl/min
100 µl	1.46 mm	0.0731 µl/hr	159.46 µl/min
250 µl	2.30 mm	0.1813 µl/hr	23.751 ml/hr
500 µl	3.26 mm	0.2184 µl/hr	28.62 ml/hr
1000 µl	4.61 mm	0.7281 µl/hr	95.418 ml/hr
1 ml	5.00 mm	0.7828 µl/hr	102.580 ml/hr
2 ml	9.00 mm	2.8493 µl/hr	373.430 ml/hr
2.5 ml	7.28 to 9.6 mm	1.8156 µl/hr	237.950 ml/hr
3 ml	8.66 to 9.0 mm	2.5691 µl/hr	336.710 ml/hr
5 ml	10.3 to 13.0 mm	4.9824 µl/hr	653.010 ml/hr
10 ml	14.57 to 15.9 mm	7.2024 µl/hr	15.733 ml/min
20 ml	19.13 to 20.05 mm	12.536 µl/hr	27.384 ml/min
30 ml	21.7 to 23.2 mm	16.131 µl/hr	35.236 ml/min
50 ml	26.7 to 32.6 mm	24.4201 µl/hr	53.346 ml/min
100 ml	34.9 to 35.7 mm	0.087 µl/min	91.20 ml/min
140 ml	38.40 mm	0.1053 µl/min	106.60 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

PHD 22/2000 and PHD 4400 Hpsi Flow Rates

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.10 mm	0.0001 µl/hr	95.330 µl/hr
1 µl	0.15 mm	0.0002 µl/hr	190.70 µl/hr
2 µl	0.21 mm	0.0004 µl/hr	381.30 µl/hr
5 µl	0.33 mm	0.0010 µl/hr	953.17 µl/hr
10 µl	0.46 mm	0.0019 µl/hr	1.901 ml/hr
25 µl	0.73 mm	0.0046 µl/hr	4.775 ml/hr
50 µl	1.03 mm	0.0092 µl/hr	9.551 ml/hr
100 µl	1.46 mm	0.0183 µl/hr	19.153 ml/hr
250 µl	2.30 mm	0.0454 µl/hr	47.532 ml/hr
500 µl	3.26 mm	0.0911 µl/hr	95.492 ml/hr
1000 µl	4.61 mm	0.0031 µl/min	190.950 ml/hr
1 ml	5.00 mm	0.0033 µl/min	205.30 ml/hr
2 ml	9.00 mm	0.0119 µl/min	747.35 ml/hr
2.5 ml	7.28 to 9.6 mm	0.0076 µl/min	476.21 ml/hr
3 ml	8.66 to 9.0 mm	0.0100 µl/min	11.231 ml/min
5 ml	10.3 to 13.0 mm	0.0208 µl/min	21.781 ml/min
10 ml	14.57 to 15.9 mm	0.0301 µl/min	31.486 ml/min
20 ml	19.13 to 20.05 mm	0.0523 µl/min	54.804 ml/min
30 ml	21.7 to 23.2 mm	0.0673 µl/min	70.518 ml/min
50 ml	26.7 to 32.6 mm	0.1019 µl/min	106.76 ml/min
100 ml	34.9 to 35.7 mm	0.1740 µl/min	182.40 ml/min
140 ml	38.40 mm	0.2106 µl/min	220.82 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

Syringe Pump Pressure and Flow Rate (continued)

Minimum/Maximum Flow Rates By Pump and Syringe Size

PHD ULTRA™ 4400 Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	3.0600 pl/min	1.59133 µl/min
1 µl	0.1457 mm	6.1200 pl/min	3.18423 µl/min
2 µl	0.206 mm	12.240 pl/min	6.36532 µl/min
5 µl	0.343 mm	33.960 pl/min	17.6471 µl/min
10 µl	0.485 mm	67.920 pl/min	35.2833 µl/min
25 µl	0.729 mm	153.480 pl/min	79.7151µl/min
50 µl	1.030 mm	306.420 pl/min	159.133 µl/min
100 µl	1.457 mm	613.200 pl/min	318.423 µl/min
250 µl	2.304 mm	1.53348 nl/min	796.252 µl/min
500 µl	3.256 mm	3.06258 nl/min	1.59021 ml/min
1 ml	4.699 mm	6.37872 nl/min	3.31205 ml/min
2.5 ml	4.851 mm	6.79806 nl/min	3.52979 ml/min
3 ml	8.585 mm	21.915 nl/min	11.0552 ml/min
5 ml	11.989 mm	41.5232 nl/min	21.5601 ml/min
8 ml	9.525 mm	26.2093 nl/min	13.6087 ml/min
10 ml	14.427 mm	60.1280 nl/min	31.2204 ml/min
20 ml	19.050 mm	104.837 nl/min	54.4347 ml/min
30 ml	21.590 mm	134.658 nl/min	69.9183 ml/min
50 ml	26.594 mm	204.311 nl/min	106.085 ml/min
100 ml	34.900 mm	351.865 nl/min	182.699 ml/min
140 ml	37.950 mm	416.009 nl/min	216.005 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

PHD ULTRA™ Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	1.500 pl/min	1.59133 µl/min
1 µl	0.1457 mm	3.060 pl/min	3.18423 µl/min
2 µl	0.206 mm	6.120 pl/min	6.36532 µl/min
5 µl	0.343 mm	16.980 pl/min	17.6471 µl/min
10 µl	0.485 mm	33.960 pl/min	35.2833 µl/min
25 µl	0.729 mm	76.740 pl/min	79.7151 µl/min
50 µl	1.030 mm	153.180 pl/min	159.133 µl/min
100 µl	1.457 mm	306.600 pl/min	318.423 µl/min
250 µl	2.304 mm	766.740 pl/min	796.252 µl/min
500 µl	3.256 mm	1.53126 nl/min	1.59021 ml/min
1 ml	4.699 mm	3.18936 nl/min	3.31205 ml/min
2.5 ml	4.851 mm	3.3990 nl/min	3.52979 ml/min
3 ml	8.585 mm	10.645 nl/min	11.0552 ml/min
5 ml	11.989 mm	20.7616 nl/min	21.5601 ml/min
8 ml	9.525 mm	13.1046 nl/min	13.6087 ml/min
10 ml	14.427 mm	30.0640 nl/min	31.2204 ml/min
20 ml	19.050 mm	52.4186 nl/min	54.4347 ml/min
30 ml	21.590 mm	67.3288 nl/min	69.9183 ml/min
50 ml	26.594 mm	102.156 nl/min	106.085 ml/min
100 ml	35.700 mm	184.091 nl/min	191.171 ml/min
140 ml	37.948 mm	208.005 nl/min	216.005 ml/min

** Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.*

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 115. 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 in2 = 77.6 PSI (5.35 bars).

Common Syringe Diameters

Volume	Diameter (mm)	Surface Area (in^2)
BD Plastic		
1 ml	4.699	0.026880
3 ml	8.585	0.089722
5 ml	11.989	0.174980
10 ml	14.427	0.253381
20 ml	19.05	0.441786
30 ml	21.59	0.567450
50/60 ml	26.594	0.860974
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

Common Syringe Diameters

Volume	Diameter (mm)	Surface Area (in^2)
Harvard Apparatus Stainless Steel		
2.5 ml	4.851	0.027937
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
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	22.9	0.638401
50 ml	29.2	1.037979
Cadence Science (formerly 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

Common Syringe Diameters

Volume	Diameter (mm)	Surface Area (in^2)
Hamilton Gastight Glass		
0.5 µl	0.103	0.000013
1 µl	0.146	0.000026
2 µl	0.206	0.000052
5 µl	0.343	0.000129
10 µl	0.485	0.000258
25 µl	0.729	0.000647
50 µl	1.03	0.001294
100 µl	1.457	0.002595
250 µl	2.304	0.006440
500 µl	3.256	0.012938
1 ml	4.608	0.025872
2.5 ml	7.285	0.064519
5 ml	10.3	0.129151
10 ml	14.567	0.258429
25 ml	23.033	0.643989
50 ml	32.573	1.293772
100 ml	32.573	1.293772
Covidien Monoject Plastic (formerly Kendall)		
1 ml	4.674	0.026323
3 ml	8.865	0.097297
6 ml	12.600	0.196350
12 ml	15.621	0.307763
20 ml	20.142	0.506621
35 ml	23.571	0.689567
60 ml	26.568	0.861362
140 ml	37.948	1.795084

How to Select the Correct Syringe for Your Application

Syringe Selection Guide

Syringe Type/Size	Swage Lock	Luer Lock	RN	Threaded 1/4-28	Luer Slip Fit	Pressure Maximum p.s.i.	Compatibility with Substance in Syringe	Accuracy 1%	Accuracy 5%	Materials
Stainless Steel Syringes, see pages 50 to 51										
2.5 ml	•					7,500	Maximum	•		316 / St. Steel
8 ml	•					1,500	Maximum	•		316 / Perfluoroelastomer
20 ml	•	•				750	Maximum	•		316 / Viton or Perfluoroelastomer
50 ml	•	•				750	Maximum	•		316 / Viton or Perfluoroelastomer
100 ml	•	•				750	Maximum	•		316 / Viton or Perfluoroelastomer
200 ml	•	•				750	Maximum	•		316 / Viton or Perfluoroelastomer
Glass GasTight Syringes, see pages 55 to 56										
1 to 100 µl		•	•	•	•	1,000	Maximum	•		Glass and PTFE
250 to 500 µl		•	•	•	•	500	Maximum	•		Glass and PTFE
1 to 10 ml		•	•	•		200	Maximum	•		Glass and PTFE
25 to 100 ml		•	•	•		100	Maximum	•		Glass and PTFE
Glass Multifit Syringes, see page 57										
2 to 50 ml		•				100	Maximum	•		Glass Only
Plastic Syringes, see pages 58 to 59										
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

French Scale and Needle Gauge Cross Reference Chart

French Scale and Needle Gauge Cross Reference Chart

	Exact French OD			Exact Gauge OD		Exact Gauge ID		Volume
French Scale	inches	mm	Needle Gauge	inches	mm	inches	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 Unit Conversion Chart

Pressure Unit Cross Reference Chart

	atm	psi	cm H_2O	mm Hg	kPa	inch H_2O	inch Hg	mbar
1 atm =	1	14.696	1033.228	760	101.325	406.783	29.921	1013.25
1 psi =	0.068	1	70.307	51.715	6.895	27.68	2.036	68.948
1 cm H_2O =	0.001	0.0142	1	0.7356	0.0981	0.3937	0.0291	0.9807
1 mm Hg =	0.0013	0.0193	1.36	1	0.133	0.5352	0.039	1.333
1 kPa =	0.0099	0.145	10.197	7500.616	1	4.015	0.295	10
1 inch H_2O =	0.0025	0.036	2.54	1.868	0.2491	1	0.0736	2.491
1 inch Hg =	0.0334	0.4912	34.532	25399	3.386	13.595	1	33.864
1 mbar =	0.001	0.015	1.02	0.7501	0.1	0.4015	0.0295	1

Force Units Conversion Table

mN	mg-force	mp
0.1	10	10.2
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	305.91
4	400	407.89
5	500	509.86
6	600	611.83
7	700	713.8
8	800	815.77
9	900	917.74

1N = 1 Newton = 1 kg m/s²

1p = 1 Pond

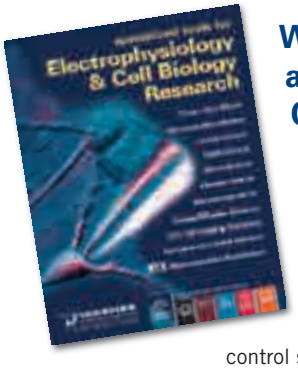
Other Literature

Catalogs and Guides

NEW Behavioral Research Catalog

Coulbourn Instruments and Panlab, both divisions of Harvard Apparatus, specialize in the manufacturing and distribution of high quality systems for behavioral research. With over 30 years of experience, Coulbourn and Panlab provide the most comprehensive and trusted solutions for behavioral studies and research.

Our new catalog offers the highest quality equipment in order to provide superior results. Application areas covered in this catalog include: Video Tracking, Operant Conditioning, Locomotor Activity & Exploration, Circadian Biology, Sensory Motor, Analgesia, Social Interaction, Learning, Memory & Attention, Anxiety & Depression, Reward & Addiction and Food & Drink/Metabolism. Our team is eager to learn more about your goals and how we can assist you in your research success.

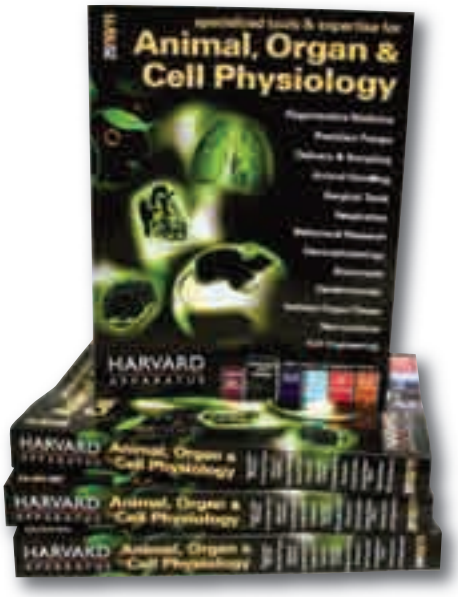


Warner Electrophysiology and Cell Biology Catalog

For the electrophysiological, cellular, and neurological sciences. Our extensive product line includes voltage and current clamp amplifiers for whole-cell and patch applications. Bessel filters, chambers for imaging and recording systems, perfusion control systems and steppers, solution heating systems, microscope translation tables, microelectrodes and holders, and glass capillary tubing, plus now includes electroporation and transfection systems from BTX.

Regenerative Medicine Catalog

Harvard Apparatus Advanced Technologies for Regenerative Medicine provides a reference for both researchers and physicians on the latest technologies in preparation and harvesting, engineering and modification, culturing and growth and condition monitoring. Our catalog includes: physiological macro- to femto- fluidic infusion pumps, animal to cell electro-physiological monitoring systems, organ to cell perfusion baths and chambers, live cell imaging and perfusion cambers and cell engineering tools from electroporation to pneumatic injectors.



Animal, Organ & Cell Physiology

This catalog features a broad range of products, including our legendary line of infusion and perfusion pumps, ventilators anesthesia systems, surgical instruments, equipment for small to larger animals, and isolated organ and tissue systems for all levels of research and education. These products are designed to help you achieve better research results in less time.

CMA Microdialysis Catalog

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Catalogs and Guides (continued)

Molecular Biology/ Sample Preparation Catalog

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Harvard Apparatus, your global partner for animal surgical research, invites you to view our top selling products for small animal surgery. We have compiled a simple and easy-to-use Guide to Small Animal Surgery. This resource offer details our comprehensive surgical lines along with the latest and most innovative products required in a pre-clinical surgical suite, from anesthesia machines to surgical instruments.

Harvard Apparatus Guide to Surgical Tools

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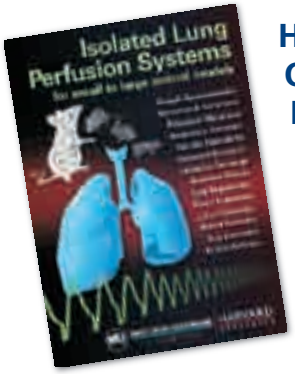
Harvard Apparatus and affiliates are cited over 850,000 times in 'Google Scholar', and over 10,000 times in 2012 alone. The following booklet contains examples of Harvard Apparatus products used in Neuroscience Research, along with summarizations of the experiments and related published articles.

Other Literature (continued)

Catalogs and Guides (continued)



Hugo Sachs Elektronik Guide to Isolated Lung Perfusion Systems

The IPL method has been found to be invaluable in characterizing the non-respiratory capabilities of pulmonary tissues such as pulmonary metabolic activity as well as the activities of various components (pulmonary alveolar macrophage, alveolar tissue, endothelial tissue, etc) in response to inhaled/ airborne particulates/therapies. Isolated lung systems are equally useful for evaluating respiratory functions such as respiratory mechanics and gas exchange.

Guide to Micro and Nano Fluidics

Guide to Micro and Nano Fluidics
This guide to Micro and Nanofluidics can help you study more variables simultaneously per time period and study smaller phenomenon for greater understanding. Reduced sample sizes can also increased experimental productivity and help provide incrementally more data and thus more information per experiment.

BTX Electroporation & Transfection Catalog

BTX offers a comprehensive line of instruments and accessories for both electroporation and electrofusion of mammalian, bacterial, yeast, fungi, insect and plant cells and tissues. BTX specializes in providing research tools for novel cutting edge applications such as adherent cell electroporation, high-throughput cloning, in vivo gene delivery, in ovo gene delivery, and in & ex utero gene delivery.

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Guide to Anesthesia and Surgical Research

This Guide to Anesthesia & Surgery provides a summary of our product line of research tools specialized for ventilation, anesthesia, animal surgery, temperature control and physiological monitoring. Products range from anesthesia flow meters, ventilation adaptation kits, intubation platforms and non-invasive pulse oximetry supplies.

Guide to Cell Modification

Choose the best Harvard Apparatus Technology to accomplish your cell modifications and re-engineering. This guide explains Liposomes, Pneumatic Injection, Iontophoresis, Electroporation and Mechanical Injectors.

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