

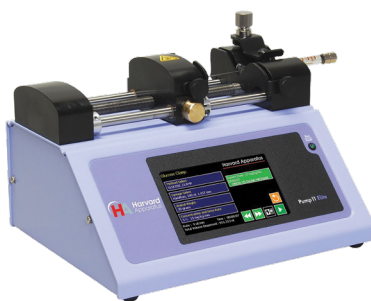
Pump Selection Guide

How to Choose the Right Pump for Your Application & Budget

1. Pump Types



PHD ULTRA™



Pump 11 Elite



Pump 33 DDS

SYRINGE PUMP

PHD ULTRA™, Pump 11 Elite, and Pump 33 DDS shown

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



P1500



P70

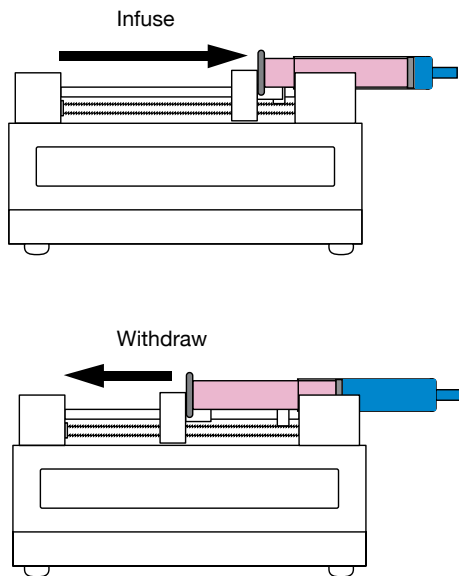
PERISTALTIC PUMP

P1500 and P70 shown

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

1. Pump Types (cont'd)

SYRINGE PUMPS



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

ADVANTAGES

- Works at pressures up to 3000 psi
- Highest precision ± 0.25 accuracy
- Pulse free flow
- Easily sterilizable
- Can dispense or withdraw
- Many easily programmable dispensing profiles including gradients
- 1 to 10 channels of operation

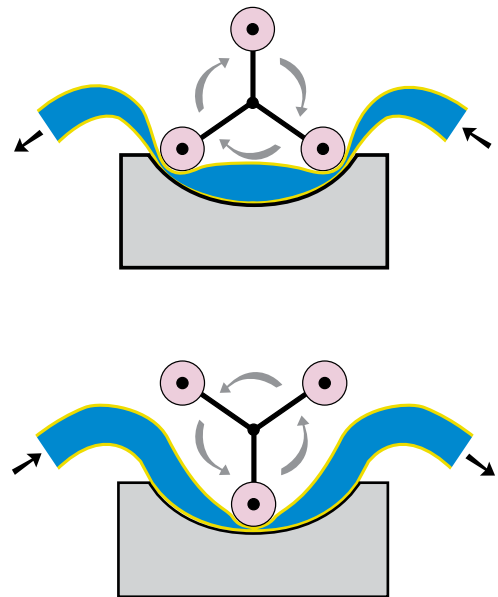
DISADVANTAGES

- Pumps finite volumes
- Slightly more expensive

TYPICAL APPLICATIONS

- Pumping sample/ calibrant into mass spectrometer
- Accurate dispensing of drugs in animals
- High pressure flow into reaction chamber
- Preclinical neuroscience or intracranial injections

PERISTALTIC PUMPS



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

ADVANTAGES

- Pumps continuous volumes
- Sterilizable
- Less expensive for multiple channel dispensing
- 1-5 channels of operation

DISADVANTAGES

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

TYPICAL APPLICATIONS

- Perfusion flow across tissue or cells
- Pump in and out with balanced flow
- Transfer bulk liquids ie. controlled animal feeding
- Dispense by weight with feedback from scale

2. Syringe Pump Selection Guide

| Features & Specifications | INFUSION ONLY | | | INFUSE/WITHDRAW | | | | | | | | PUSH/PULL | | CONSTANT PRESSURE |
|-----------------------------------|----------------------------|----------------------------|-------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|---|-------------------------------|-------------------------------|--------------------------------|---------------------------------------|-----------------------|-------------------------------|
| STANDARD PUMP MODEL | Pump 11 Elite | Pump 11 Elite | PHD ULTRA™ | Pump 11 Elite | Pump 11 Elite | Pump 11 Pico Elite | Pump 11 Pico Elite | Nanomite | PHD ULTRA™ | PHD ULTRA™ 4400 | PHD ULTRA™ XF | PHD ULTRA™ | Pump 33 DDS | PHD ULTRA™ |
| Programmable Model | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes |
| Number of Syringes | 1 | 2 | 2 to 10* | 1 | 2 | 1 | 2 | 1 | 2 to 10* | 1 | 4 | 4 (2 on each side of pusher block) | 2 (independent) | 2 |
| Minimum Syringe Size | 0.5 µl | 0.5 µl | 0.5 µl | 0.5 µl | 0.5 µl | 0.5 µl | 0.5 µl | 0.5 µl | 0.5 µl | 2.5 ml | 20 ml | 0.5 µl | 0.5 µl | 0.5 µl |
| Maximum Syringe Size | 60 ml | 10 ml | 140 ml | 60 ml | 10 ml | 60 ml | 10 ml | 1 ml | 140 ml | 140 ml | 200 ml | 140 ml | 60 ml | 140 ml |
| Minimum Flow Rate 0.0014 µl/hr | 1.26 pl/min | 1.26 pl/min | 1.5 pl/min | 1.26 pl/min | 1.26 pl/min | 0.54 pl/min | 0.54 pl/min | 3.7 pl/min | 1.5 pl/min | 3 pl/min | 51 nl/min | 1.5 pl/min | 1.1 pl/min | 1.5 pl/min |
| Maximum Flow Rate 26.56 ml/min | 88 ml/min | 26 ml/min | 216 ml/min | 88 ml/min | 26 ml/min | 39 ml/min | 11 ml/min | 3.8 ml/min | 216 ml/min | 216 ml/min | 144 ml/min | 216 ml/min | 106 ml/min | 216 ml/min |
| Average Linear Force (lbs) | 35 | 35 | 75 | 35 | 35 | 35 | 35 | 11 | 75 | 200 | 2,000 | 75 | 70 | 75 |
| USB | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| RS-232 Computer Control | No | No | Yes | Optional | Optional | Optional | Optional | Optional | Yes | Yes | No | Yes | Yes | Yes |
| TTL Connection | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dimensions (W x D x H) | 22.6 x 17.78 x 15 cm | 22.6 x 17.78 x 15 cm | 30.48 x 21.59 x 17.8 cm | 22.6 x 17.78 x 15 cm | 22.6 x 17.78 x 15 cm | 22.6 x 17.78 x 15 cm | 22.6 x 17.78 x 15 cm | 22.6 x 17.78 x 9.32 cm Injector: 6.35 x 5.08 x 19.05 cm | 30.48 x 21.59 x 17.8 cm | 30.48 x 21.59 x 18.4 cm | 40.64 x 30.48 x 19.69 cm | 30.48 x 21.59 x 17.8 cm | 28 x 39 x 21 cm | 30.48 x 21.59 x 17.8 cm |
| Weight | 2.1 kg | 2.1 kg | 4.5 kg | 2.1 kg | 2.1 kg | 2.1 kg | 2.1 kg | 1.96 kg Injector: 0.53 kg | 4.5 kg | 5.5 kg | 11.64 kg | 4.5 kg | 9.09 kg | 4.5 kg |
| Ordering Information | | | | | | | | | | | | | | |
| Standalone Catalogue # | 70-4500 | 70-4501 | 70-3005 | 70-4504 | 70-4505 | 70-4511 | 70-4506 | 70-4507 | 70-3007 | 70-3010 | No | 70-3009 | 70-3333 | 88-3015 |
| OEM Pump Module | No | No | No | 70-4804 | 70-4805 | 70-4807 | 70-4806 | No | 70-3406 | 70-3410 | No | 70-3408 | No | No |
| Satellite | No | No | No | No | No | No | No | 70-3602 | 70-3506 | 70-3510 | 70-3514 | 70-3508 | No | No |
| Open Baseplate Pump Component | No | No | No | 70-4810 | 70-4811 | 70-4812 | 70-4813 | No | No | 70-3610 | No | No | No | No |

Key Questions to Define Your Pump Needs

- How many syringes will be used simultaneously?
- What size syringe will be used?
- What flow rate(s) will be used?
- What is the total volume to be delivered?
- Does the pump need to withdraw (fill the syringe) as well as infuse (dispense)?
- What is the viscosity of the liquid you are pumping?
- What are the pressure requirements of your experiment?
- Does the pump need to continuously infuse large volumes (larger than 500mL)?
- Does the pump need to vary its flow rate over time?

Standalone Pump

Has a glove-safe touch screen and can be operated without any additional equipment.

Open Baseplate Pump Component

Intended for integration into other devices. Can be controlled from PC or microcontroller. Not enclosed.

OEM Pump Module

Can be controlled from a PC or a HAPC Pump Controller. Fully enclosed/splashproof.

Satellite Pump

Can be controlled from an HAPC Pump Controller only. Fully enclosed/splashproof.

* Can mount up to 10x syringes with the (optional) syringe rack accessory

• Syringe Rack Maximum syringe size & count varies depending upon model
• 4 x 140 Syringe Rack Holds four 60 ml to 140 ml plastic syringes only
• 6 x 10 Syringe Rack Holds six 30 to 60 ml syringes or ten 0.5 µ l to 20 ml syringes
• Microliter Syringe Rack Holds four 0.5 µ l to 10 ml syringes

3. Syringe Pump Recommended Application Guide

| Syringe Pump Application Guide | | | | | | | | |
|--------------------------------------|----------------------|--------------------|----------|------------|-----------------|---------------|-------------|----------------------|
| | Pump 11 Elite | Pump 11 Pico Elite | Nanomite | PHD ULTRA™ | PHD ULTRA™ 4400 | PHD ULTRA™ XF | Pump 33 DDS | PHD ULTRA™ Push/Pull |
| 3D Printing | OEM Module | | | | OEM Module | | | |
| Bulk Fluid Transfer | | | | | | | ✓ | ✓ |
| Cell Cultures | ✓ | | | ✓ | | | | |
| Cellular Injection | ✓ | ✓ | ✓ | | | | | |
| Continuous Infusions | | | | ✓ | | | ✓ | ✓ |
| Constant Pressure Injection | | | | CP Pump | | | | |
| Drug Delivery | ✓ | | ✓ | | | | | |
| Drug Delivery (Multiple Animals) | | | | ✓ | | | | |
| Drug Development | | | | ✓ | | | | |
| Electrospinning | ✓ | | | | | | | |
| Encapsulation | | | | ✓ | | | ✓ | |
| Filtration | ✓ | | | | | | | |
| Flow Cytometry | ✓ | ✓ | | | | | | |
| Fluid Blending (Multiple Channels) | | | | ✓ | | | ✓ | |
| Fluid Sampling | ✓ | | | ✓ | | | ✓ | |
| Gradients | 1/Channel, with HAPC | | | 1/Channel | 1/Channel | | | |
| High Pressure Injection | | | | | ✓ | ✓ | | |
| HPLC | ✓ | | | | | | | |
| Intracranial Injection/ Neuroscience | | | ✓ | | | | | |
| Mass Spectrometry / Chromatography | ✓ | | | | | | | |
| Microdialysis | ✓ | ✓ | | | | | | |
| MRI Studies | | | | OEM Module | | | | |
| Microfluidics | ✓ | ✓ | | | | | | |
| Nano-Particles Generation | | | | ✓ | | | ✓ | |
| Oocyte Applications | | ✓ | | | | | | |
| Reaction Vessels | | | | ✓ | ✓ | ✓ | | |
| Remote Pumping of Hazardous Material | OEM Module | OEM Module | | OEM Module | OEM Module | | | |
| Spray Coating | | | | | | | ✓ | ✓ |
| Stereotaxic Devices | | | ✓ | | | | | |
| Titrations | ✓ | | | ✓ | | | | |
| Viscous Solutions | | | | | ✓ | ✓ | | |

4. Peristaltic Pump Selection Guide

- Wide range of flow rates ml/hr to L/min
- Multiple multi-channel models, including independent channels
- Weight scale integration
- Continuous delivery and batch mode dispensing

Harvard Apparatus now offers a selection of peristaltic and other continuous flow pumps to suit the needs of a wide range of research applications. Pumps which offer features such as multi-channel pumping, computer control, analog control, low electrical noise and a wide range of fluid flow rates are now available. This 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 (4 to 8) to push fluid through tubing held within a pump head. Peristaltic flow is typically pulsatile, but can be made smoother with the use of more rollers in the pumping head or with the addition of a Windkessel (73-2068). Many pumps offer external control either through the input of an analog signal proportional to the speed or by USB & RS-232 (serial) communication.

Key Questions to Define Your Pump Needs

How many channels (tubes) will be used simultaneously?

- What size tubing will be used (inner diameter)?
- What flow rate(s) will be used?
- Do you need to control the pump with a computer?
- Do you need analog control?
- Do you need weight scale feedback?

| Pump Selection Guide | | | | | |
|--|-----------------------|-----------------------|--------------------------------------|----------------------|--------------------------|
| | P70 | P1500 | P1500 Weight Scale Integration | Masterflex™ Reglo | Masterflex™ Reglo ICC |
| Number of Channels | 5 | 1 | 1 | 2 to 4 | 2 to 4 |
| Number of Rollers | 8 | 4 | 4 | 6-12 | 6-12 |
| Tube Size (Inner Diameter) | 0.13 to 2.79 mm | 0.8 to 8.0mm | 0.8 to 8.0mm | 0.13 to 3.17 mm | 0.13 to 3.17 mm |
| Enclosure Rating: | IP32 | IP32 | IP32 | IP31 | IP31 |
| USB | Yes | Yes | Yes | No | No |
| RS-232 Computer Control | Optional | Optional | Yes | No | No |
| TTL Control | Yes | Yes | Yes | Yes | Yes |
| Analog Control | Yes | Yes | Yes | Yes | Yes |
| Active Feedback (from Weight Scale) | - | - | Yes | - | - |
| Remote Pump-Head for Incubator / Fumehood | Yes | Yes | Yes | No | No |
| Flow Rate: | | | | | |
| Minimum | 0.001 ml/min | 0.001 ml/min | 0.001 ml/min | 0.000 | 0.000 |
| Maximum | 70 ml/min | 1,500 ml/min | 1,500 ml/min | 0.1 ul/min | 0.1 ul/min |
| Dimensions (H x W x D): | | | | | |
| Control Box | 20.7 x 13 x 9.6 cm | 20.7 x 13 x 9.6 cm | 20.7 x 13 x 9.6 cm | Yes | Yes |
| Pump Module | 11.5 x 25.4 x 11.8 cm | 11.5 x 25.4 x 11.8 cm | 11.5 x 25.4 x 11.8 cm | - | 17.0 x 12.5 x 20.5 cm |
| Weight | 4.7 kg | 5 kg | 5 kg | 2.6 kg | 2.7 kg |

Appendices

Pressure-based Pump and Syringe Selection

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 8. 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. If you need assistance determining your pressure requirements, please contact our Technical Support team at support.harvardapparatus.com with the following information:

- Syringe size you plan to use
- Flow rate of the material
- Tubing length
- Tubing inside diameter
- Viscosity of the material being pumped

| Pump Average Pressure (PSI) | | | | | | |
|-----------------------------|----------------------------|---------------------------|--------------|------------|-----------------|---------------|
| Syringe | Syringe Dia (mm - typical) | Pump 11 Elite / PicoElite | Pump 33 DDS* | PHD ULTRA™ | PHD ULTRA™ 4400 | PHD ULTRA™ XF |
| 1 ml (or smaller) | 5 | >1000 | >1000 | >1000 | >1000 | x |
| 5 ml | 10 | 287 | 575 | 616 | 1642 | x |
| 10 ml | 15 | 127 | 255 | 273 | 730 | x |
| 20 ml | 20 | 71 | 143 | 154 | 410 | 2053 |
| 50 ml | 25 | 46 | 92 | 98 | 262 | 1314 |
| 100 ml | 32.5 | 27 | 54 | 58 | 154 | 773 |
| 200 ml | 44.75 | x | x | x | x | 410 |
| Force (lbs) | x | 35 | 70* | 75 | 200 | 2,000 |

Notes for Table

Available pressure is calculated based on the minimum available force when pump force is set to 100%

- Higher pressures may be achieved at low speed
- Most syringes are pressure rated and may not be able to tolerate the pressure generated by the syringe pump.

Consult Harvard Apparatus or your syringe manufacturer for syringe details and specifications.

To convert pressure from PSI to bars use the following equation:
bar pressure = PSI x 0.0690.

Actual pressure will depend on the fluidic system as discussed above.

Syringes pressure ratings (typical - will vary by manufacturer)

Plastic <20ml 45 PSI

Plastic >20ml 30 PSI

Glass gastight <20 ml 200 PSI

Steel syringe <20 ml 1,500 PSI or 7,000 PSI

Steel syringe >20 ml 750 PS

**Pump 33 DDS force drops when flow rate is above 85% of max.
Please contact Technical Support for more information.*

Appendices

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 syringe pumps come preloaded with common syringe data, and data for other syringes can be added by entering the diameter. The pump uses this diameter data to set flow rates. All Harvard Apparatus pumps have this information built into the pump memory in a handy Syringe Look Up Table. Available 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. For example, nominal pressure obtained using two 25 ml Hamilton Gastight® syringes on a PHD ULTRA™ standard pressure syringe pump would be: 75 lbs / (0.644 in² x 2) = 58.23 PSI (4 bar).

| Volume | Dia. (mm) | Surface Area (in ²) |
|--|-----------|---------------------------------|
| BD Plastic | | |
| 1 ml | 4.78 | 0.027815 |
| 3 ml | 8.66 | 0.091297 |
| 5 ml | 12.06 | 0.177059 |
| 10 ml | 14.5 | 0.255952 |
| 20 ml | 19.13 | 0.445505 |
| 30 ml | 21.7 | 0.573247 |
| 50/60 ml | 26.7 | 0.867851 |
| SGE Glass | | |
| 25 µl | 0.73 | 0.000649 |
| 50 µl | 1.03 | 0.001292 |
| 100 µl | 1.46 | 0.002595 |
| 250 µl | 2.3 | 0.006440 |
| 500 µl | 3.26 | 0.012938 |
| 1 ml | 4.61 | 0.025872 |
| 2.5 ml | 7.28 | 0.064519 |
| 5 ml | 10.3 | 0.129151 |
| 10 ml | 14.57 | 0.258429 |
| Harvard Apparatus Stainless Steel | | |
| 2.5 ml | 4.791 | 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 |

| Volume | Dia. (mm) | Surface Area (in ²) |
|--------------------------------|-----------|---------------------------------|
| Terumo Plastic | | |
| 3 ml | 8.95 | 0.097514 |
| 5 ml | 13 | 0.205735 |
| 10 ml | 15.8 | 0.303904 |
| 20 ml | 20.15 | 0.494279 |
| 30 ml | 23.1 | 0.649601 |
| 60 ml | 29.1 | 1.030881 |
| Air-Tite All Plastic | | |
| 2.5 ml | 9.6 | 0.112193 |
| 5 ml | 12.45 | 0.188695 |
| 10 ml | 15.9 | 0.307763 |
| 20 ml | 20.05 | 0.489386 |
| 30 ml | 22.5 | 0.616293 |
| 50 ml | 29 | 1.023808 |
| Cadence Perfectum Glass | | |
| 0.5 ml | 3.45 | 0.014490 |
| 1 ml | 4.5 | 0.024652 |
| 2 ml | 8.92 | 0.096862 |
| 3 ml | 8.99 | 0.098388 |
| 5 ml | 11.7 | 0.166646 |
| 10 ml | 14.7 | 0.263061 |
| 20 ml | 19.58 | 0.466711 |
| 30 ml | 22.7 | 0.627298 |
| 50 ml | 29 | 1.023808 |
| 100 ml | 35.7 | 1.551525 |

| Volume | Dia. (mm) | Surface Area (in ²) |
|--------------------------------|-----------|---------------------------------|
| Hamilton Gastight Glass | | |
| 0.5 µl | 0.103 | 0.000013 |
| 1 µl | 0.1457 | 0.000026 |
| 2 µl | 0.206 | 0.000052 |
| 5 µl | 0.3257 | 0.000129 |
| 10 µl | 0.46 | 0.000258 |
| 25 µl | 0.729 | 0.000647 |
| 50 µl | 1.031 | 0.001294 |
| 100 µl | 1.46 | 0.002595 |
| 250 µl | 2.3 | 0.006440 |
| 500 µl | 3.26 | 0.012938 |
| 1000 µl | 4.61 | 0.025872 |
| 2.5 ml | 7.28 | 0.064519 |
| 5 ml | 10.3 | 0.129151 |
| 10 ml | 14.57 | 0.258429 |
| 25 ml | 23 | 0.643989 |
| 50 ml | 32.6 | 1.293772 |
| Monoject Plastic | | |
| 1 ml | 4.65 | 0.026323 |
| 3 ml | 8.94 | 0.097297 |
| 6 ml | 12.7 | 0.196350 |
| 12 ml | 15.9 | 0.307763 |
| 20 ml | 20.4 | 0.506621 |
| 35 ml | 23.8 | 0.689567 |
| 60 ml | 26.6 | 0.861362 |

Setting the Standard in Pump Technology.

Need Additional Help Choosing a Pump?

This guide was developed to help you choose the right pump for your application. For further assistance selecting the ideal pump for your needs, please contact our Technical Support team by visiting our online Support Center at support.harvardapparatus.com.

Contact Us to Order

Email

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