

## Comparison of External Pumps

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FTA offers two types of optional external pumps that can be installed in place of the original dispenser. In general, these can be fitted to the FTA100 series instruments and the FTA200, but not all configurations are possible. In general they can be retrofitted to existing instruments. A table below lists the compatible choices. There are two pump types: a peristaltic pump and a syringe pump. Each has its advantages and disadvantages.

### Peristaltic Pump

A peristaltic pump works by squeezing tubing with rollers that move along the tubing in a rotary fashion. The chief advantage of the peristaltic pump is that it is reliable, rugged and inexpensive by comparison to the alternatives. The peristaltic pump has a completely disposable fluid path and is self-priming. The chief disadvantage is that the fluid flow is not uniform as the rollers move over the surface, so there are pauses in the flow. For some applications, this is not a problem but for others it is.

Because the flow is not uniform in time, a peristaltic pump is operate differently than a syringe pump. The pump is started and then stopped when

- the user decides from the video image that enough liquid has been dispensed, or
- the video trigger is used to halt the pump after the droplet reaches a certain point in the image.

The peristaltic pump can be operated in both dispense and aspirate mode, so liquid can be sucked back in if too much is dispensed. The pump can be operated slowly enough that either of the two stopping modes works well and it can be turned off in a fraction of a second by the video trigger.

A syringe pump, on the other hand, can be programmed to dispense a precise amount.

The peristaltic pump uses an external vial or bottle for a liquid source, so there is no practical limit to how much is dispensed before refilling.

## Syringe Pump

The classic syringe pump is now fitted with a three-way valve so that it can self-prime, so the syringe itself need never be removed from the pump in ordinary operation. The syringe pump's range and delivery rate can be scaled over a wide range by selecting different volume syringes. The syringe pump is very precise but is not suitable for directly handling damaging liquids such as inks; these can be dispensed using a more complicated aspirate/dispense cycle with an airgap however. The syringe pump has a resolution of 12,000 true hardware steps over the syringe volume.

The maximum volume delivered in any one stroke is the volume of the selected syringe. Practical syringe volumes are 50 to 1000 $\mu$ l. The syringe can then be refilled by setting the valve to the source vial and aspirating.

## Applications

The peristaltic pump is excellent for simple contact angle dispense where the pendant drop will detach from the needle. It can also be used for simple surface tension work where a stable pendant drop is hung for analysis. The peristaltic pump should not be used when the drop volume is to be modulated by the pump, e.g., in captive needle advancing/receding contact angle analysis or in dilation stress interfacial tension analysis.

The syringe pump is always suitable unless you need a disposable fluid path and can use a peristaltic pump.

The syringe pump is very suitable for dilational stress work as it can be programmed for true sine wave dispense and repetition rates up to 10Hz.

## Performance Specifications

Two minimum flows are shown for the syringe pump:

- at 40 steps per second, the flow is laminar and no pulsation can be observed
- at rates slower than 40 per second, the individual steps can gradually be observed until they are clear at 1 step per second. While the flow is then stepwise, the volume delivered is precisely correct. Slow, laminar flow is achieved by using a smaller syringe. For the smaller syringes, the quoted 40/s rate is very conservative because the interconnecting tubing absorbs these small steps well.

No specific resolution is shown for a peristaltic pump because it is turned off at a given time rather than after a certain number of stepper motor steps.

Pump	Parameter	Value	Comment
<b>Peristaltic</b>			
1.6mm=1/16" ID tube	Minimum dispense rate	0.9 $\mu$ l/s	
	Maximum dispense rate	60 $\mu$ l/s	
	Resolution	N/A	turn off in time, not volume
0.8mm=1/32" ID tube	Minimum dispense rate	0.225 $\mu$ l/s	
	Maximum dispense rate	15 $\mu$ l/s	
	Resolution	N/A	turn off in time, not volume
<b>Syringe</b>			
1ml syringe	Minimum dispense rate	0.083 $\mu$ l/s	@ 1 step per second
	Minimum laminar rate	3.33 $\mu$ l/s	@ 40 steps per second
	Maximum dispense rate	100 $\mu$ l/s	limited by fluid flow, not pump
	Resolution	0.083 $\mu$ l	12,000 step resolution
500 $\mu$ l syringe	Minimum dispense rate	0.042 $\mu$ l/s	@ 1 step per second
	Minimum laminar rate	1.67 $\mu$ l/s	@ 40 steps per second
	Maximum dispense rate	100 $\mu$ l/s	limited by fluid flow, not pump
	Resolution	0.042 $\mu$ l	12,000 step resolution
250 $\mu$ l syringe	Minimum dispense rate	0.021 $\mu$ l/s	@ 1 step per second
	Minimum laminar rate	0.83 $\mu$ l/s	@ 40 steps per second
	Maximum dispense rate	100 $\mu$ l/s	limited by fluid flow, not pump
	Resolution	0.021 $\mu$ l	12,000 step resolution
100 $\mu$ l syringe	Minimum dispense rate	0.008 $\mu$ l/s	@ 1 step per second
	Minimum laminar rate	0.33 $\mu$ l/s	@ 40 steps per second
	Maximum dispense rate	50 $\mu$ l/s	
	Resolution	0.008 $\mu$ l	12,000 step resolution
50 $\mu$ l syringe	Minimum dispense rate	0.004 $\mu$ l/s	@ 1 step per second
	Minimum laminar rate	0.16 $\mu$ l/s	@ 40 steps per second
	Maximum dispense rate	25 $\mu$ l/s	
	Resolution	0.004 $\mu$ l	12,000 step resolution

## Available Configurations

Instrument	Peristaltic		Syringe	
	Single uses existing rack and pinion Z stage	Quad uses existing rack and pinion Z stage, plus provides stepper driven rotary tip wheel	Single FTA100 series use existing rack and pinion Z stage. FTA200 provides micrometer Z stage or optional stepper driven Z stage	Quad FTA100 series use existing rack and pinion Z stage. FTA200 provides micrometer Z stage or optional stepper driven Z stage. Both provide stepper driven rotary tip wheel
FTA125 QA model	✓		✓	
FTA135 large wafer model	✓		✓	
FTA136 top view glass	✓		✓	
FTA137 large sample	✓		✓	
FTA188 general purpose	✓	✓	✓	✓
FTA200 laboratory			✓	✓

Six pump configurations are available on special request.