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Subject	ATLAS pump accuracy and resolution information
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## Atlas Pumps - Accuracy:

To be completely accurate, the following is the definition of how accurate the system is:

### Accuracy and Precision

Accuracy is described by two parameters: accuracy and precision. For both, the value given is expressed as a percentage of the full stroke of the syringe.

Accuracy measures how closely a dispensed amount of fluid corresponds to the ideal programmed value. Precision describes the ability of the drive to deliver the same quantity of fluid for the same size programmed dispenses.

By analogy, consider an archer shooting a group of arrows at a target. Precision is a measure of how closely the arrows are spaced on the target, called the size of the group.

Accuracy is a measure of how far the center of that group is from the center of the target. The values for the Asia Syringe pumps are:

- Accuracy 0.20% CV (typical, full-stroke), 0.4% max
- Precision 0.06% CV (typical, full-stroke), 0.12% max

Additional factors contributing to system accuracy are the total syringe size, any air bubbles or gaps, and any elasticity in the fluid path.

The syringe tolerance is a maximum  $\pm 1\%$  of total volume.

This error contribution is proportional to the amount dispensed as a fraction of syringe volume. Air bubbles, gaps, and tubing elasticity can contribute errors due to compressibility or expansion of their volumes.

Such errors are proportional to the positive or negative fluid pressures in the fluid path.

Therefore, every stroke of the Atlas pump, we would expect 0.4% accuracy and 0.12% precision on each stroke. As mentioned above, external atmospheric events like bubbles, small temperature changes are what would cause the majority of errors.

## Pump stroke resolution:

The length of each stroke, irrespective of the syringe size, is 12000 steps. Therefore the set flow rate determines the steps per minute.

The data set by both the hardware and tweaked by the firmware gives a minimum smooth flow rate of 40 steps per second.

Similarly, the hardware and firmware gives a less smooth flow rate of 1 step per second

Example: A syringe is being used with a volume of 50 ul

Therefore:

Minimum smooth flow rate (ul/min) =  $50 / 12000 \times 40 \times 60 = 10 \text{ ul/min}$

Min less smooth flow rate (ul/min) =  $50 / 12000 \times 1 \times 60 = 0.25 \text{ ul/min}$

This calculation does not take into account any environmental factors (eg viscosity) which could affect the stability of the pump steps.

Therefore, we could not guarantee 100% accuracy in the less smooth flow rate area.

The flow rates we recommend are calculated as percentages of the syringe volume and are different for individual dosing modes.

In Continuous dosing mode we would recommend a minimum flow rate of 20% of the syringe volume per minute.

In Dual dosing mode, where the smoothness of the flow rate is less magnified is 1% of syringe volume.

More technical data here <http://syrris.com/batch-products/atlas-syringe-pump>