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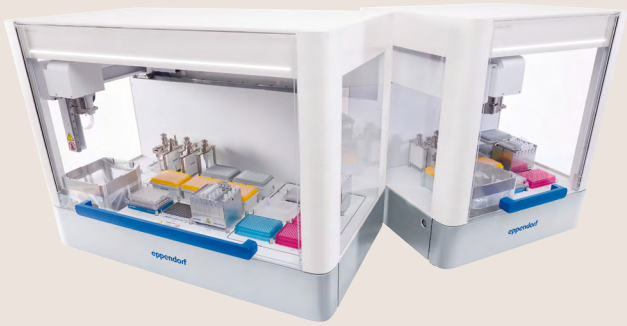
WHITE PAPER No. 127

Evaluation of the Eppendorf epMotion® Pipetting Tools using the Artel MVS®

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Abstract

The performance of the epMotion liquid handling system was comprehensively characterized using the third-party Artel® Multichannel Verification system (MVS®). Single-, four-, and eight channel pipetting tools were tested to determine accuracy and precision across multiple dispensing volumes at each tool's range. Artel MVS results demonstrated that the instrument generated high accuracy and precision that exceeded Eppendorf's product specifications. The combination of the Artel MVS and epMotion system validate that precise and accurate liquid handling can be achieved across diverse configurations and experimental setups.



Introduction

Accuracy and precision of automated liquid handlers are critical performance specifications for high quality laboratory workflows. Liquid handling processes in a workflow may range from nucleic acid extractions to next generation sequencing (NGS), and it is important to reduce instrument variability in these workflows. Evaluating the performance of automated liquid handlers provides a tangible way to control risk, ensuring accuracy and consistency even when working with minimal volumes. As laboratory work continues to evolve, the demand for flexible pipetting solutions grows. As plate formats change between assay setups in a workflow, the need for accurate and precise pipetting by liquid handling instruments becomes crucial for high-quality, reliable results. By understanding and optimizing the performance of liquid handling systems, laboratories can effectively eliminate this potential source of error, minimizing troubleshooting time and reducing the need for repeat testing.

A method for assessing instrument performance that is fast, easy, and reliable is crucial to the effort to reduce re-work through increased reliability of liquid handlers. Additionally, the liquid handling instrumentation must be able to achieve acceptable performance. The combination of the epMotion workstations and the Artel MVS achieves these goals.

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The Eppendorf epMotion® 5073/5075 can be equipped with eleven pipetting tools covering a volume range of 0.2 µL–1,000 µL. To achieve the best performance, single channel pipetting tools with four volume ranges (0.2–10 µL, 1–50 µL, 20–300 µL and 40–1,000 µL) are used to meet the most rigorous requirements for accuracy and precision for routine liquid handling. Moreover, the pipetting tools are available in 4-channel and 8-channel formats. The 4-channel tool provides greater throughput than the single channel tool and enhances the versatility of the plate format for the user.

These automatically exchangeable pipetting tools are compatible with the epMotion 5073/5075 systems, ensuring universal performance regardless of specific workstations.

The 4-channel dispensing tools are compatible with epBlue software version ≥ 50.2 and epMotion 5073/5075 systems with serial numbers ≥ 10.000.

The Artel MVS (Nova Biomedical, Waltham, MA) is an easy-to-use, universal system that provides performance assessment for every liquid handling instrument used in an assay workflow. With its ability to determine accuracy and precision performance on a tip-by-tip or well-by-well basis, the MVS dramatically reduces the time and effort needed to ensure that liquid handlers, mixers, or plate washers are performing optimally. The MVS produces results that are traceable to the International System of Units (SI).

Material and Methods

The MVS is comprised of the following components: a microtiter plate reader, a bar code reader, a microtiter plate shaker, a calibrator plate, sample and diluent QualAssure® solutions, dimensionally characterized microtiter plates, and system-specific software. The six different MVS sample QualAssure solutions contain a fixed concentration of blue dye and red dye that is in a specific concentration relating to a specific volume measurement range which spans from 350 µL to 10 nL. The smaller the volume to be measured, the higher the concentration of red dye used in the sample QualAssure solution. MVS diluent contains only the blue dye at the same concentration as in the sample QualAssure solutions. The diluent is used to bring the wells to an optimal total solution volume which is necessary for making comparable pathlength measurements in each well. For the tests presented here, we used four different solutions.

The workflow for an MVS experiment involves aspirating and dispensing a target volume of the appropriate sample solution into a vessel containing the diluent solution. After mixing the sample and diluent QualAssure solution, the absorbance values of both dyes are measured in each test well and the system software calculates the volume of sample QualAssure solution present in each well. The MVS reports both the accuracy and precision of the volume delivered by each channel of an instrument in a single experiment. Results are traceable to the International System of Units (SI) through reference standards developed and maintained by the National Institute of Standards and Technology (NIST, USA). The system reports inaccuracy < 2 % and imprecision < 0.4 % CV for most volumes.

An epMotion 5075 system (Eppendorf SE, Hamburg, Germany) was utilized with the following components: epMotion 5075 liquid handler, software, dispensing tools (TS 10 and TM 10-8, TS-50, TS-300, TS-1000, TM 50-8, TM 300-8, TM 1000-8, TM 50-4, TM 300-4 1000, TM 1000-4), epT.I.P.S.® Motion, and 30 mL reagent reservoirs. The epMotion 5075 was programmed to dispense a series of target volumes, from 0.2µL–300µL.

This study compared the performance of the 10µL tool, single channel, 4-channel, and 8-channel dispensing tools through aspiration and dispensing of MVS sample QualAssure solutions in 30-mL reagent reservoirs into characterized 96-well plates. Target volumes were selected to span the entire volume range of the dispensing tool (200 nL–10 µL). In the 10 µL single-channel dispensing tools experiments, three columns of the plate were filled (n=24). In experiments using the 10 µL 8-channel dispensing tool, 32 wells (four columns) were filled. To test the single channel dispensing tools (TS-50, TS-300, TS-1000), two columns of a characterized 96-well plate were filled (n=16). To test the 8-channel dispensing tools (TM 50-8, TM 300-8, TM 1000-8), an entire plate was filled (n=96). For the 4-channel dispensing tools (TM 50-4, TM 300-4, TM 1000-4), 48 wells (12 columns) of the plate were filled (n=12). The epMotion was used in a non-environmentally controlled laboratory setting to deliver both the sample and the diluent QualAssure solutions.
Tips were changed between each solution type. The values, as reported by the MVS, were compared to the published epMotion 5070/5075 technical specifications.

Results and Discussion

The technical specifications for the epMotion 5070/5073/5075 10 µL pipetting tools, as well as single- and 8-channel pipetting tools can be found in Table 1. The technical specifications for the epMotion 5070/5075 single- and multi-channel dispensing tools can be found in Table 1.

The experimental data determined by the MVS for the single channel dispensing tool, 4-channel dispensing tool, and 8-channel dispensing tools can be found in Tables 2,3, and 4 respectively.

Table 1: Technical specifications for the epMotion 10 µL pipetting tool, single- and 8-channel tools.

Dispensing Tool	Target Volume (µL)	Relative Inaccuracy %	CV %
TS 10	0.2	25	19.8
TS 10	1	5	3
TS 10	5	2.4	0.5
TS 10	10	1.2	0.25
TM 10-8	1	7.5	5
TM 10-8	5	2.5	2
TM 10-8	10	2	0.6
TS 50	5.0	10.0	4.0
TS 50	25.0	2.0	0.8
TS 50	50.0	1.0	0.4
TS 300	30.0	7.0	3.0
TS 300	150.0	1.6	0.6
TS 1000	100.0	4.0	1.5
TM 50-8	5.0	15.0	6.0
TM 50-8	25.0	3.0	1.2
TM 50-8	50.0	1.5	0.6
TM 300-8	30.0	10.0	4.5
TM 300-8	150.0	3.0	1.2
TM 1000-8	100.0	6.0	2.3

Table 2: Measured performance of the epMotion single-channel tools.

Dispensing Tool	Target Vol. (µL)	Average Vol. (µL)	Relative Inaccuracy %	CV %
TS 10	0.2	0.21632	8.16	1.76
	0.5	0.51365	2.72	0.70
	1	1.01133	1.13	0.64
	5	4.97323	-0.55	0.14
	10	10.03763	0.37	0.27
TS 50	1	1.0543	5.43	1.58
	5	5.133	2.66	0.29
	10	10.069	0.69	0.25
	25	25.16	0.64	0.12
	50	50.32	0.64	0.20
TS 300	20	19.83	-0.85	0.20
	30	29.95	-0.17	0.10
	100	99.70	-0.30	0.07
	150	149.9	-0.07	0.13
	300	302.1	0.70	0.13
TS 1000	40	39.67	-0.82	0.23
	45	44.74	-0.58	0.25
	50	49.76	-0.48	0.30
	100	100.94	0.94	0.25
	200	202.70	1.35	0.10

Table 3: Measured performance of the epMotion 4-channel tool.

Dispensing Tool	Target Vol. (µL)	Average Vol. (µL)	Relative Inaccuracy %	CV %
TM 50-4	1	1.0246	2.47	0.81
	5	5.1140	2.28	0.32
	10	10.0741	0.74	0.20
	25	25.325	1.30	0.12
	50	50.002	0.00	0.17
TM 300-4	20	19.950	-0.25	1.27
	30	29.755	-0.82	0.42
	100	99.091	-0.91	0.58
	150	149.319	-0.45	0.55
	300	300.440	0.15	0.41
TM 1000-4	40	40.022	0.06	1.41
	45	45.000	0.00	1.22
	50	49.758	-0.48	0.45
	100	99.270	-0.73	0.28
	200	199.810	-0.10	0.15

Table 4: Measured performance of the epMotion 8-channel tool.

Dispensing Tool	Target Vol. (µL)	Average Vol. (µL)	Relative Inaccuracy %	CV %
TM 10-8	0.2	0.21508	7.54	3.42
	0.5	0.49783	-0.43	2.14
	1	1.0031	0.31	1.97
	5	5.0498	1.00	0.31
	10	9.98904	-0.11	0.34
TM 50-8	1	0.9945	-0.55	1.30
	5	5.053	1.06	0.42
	10	10.083	0.83	0.26
	25	25.13	0.52	0.16
	50	50.00	0.00	0.32
TM 300-8	20	19.63	-1.85	1.53
	30	29.15	-2.83	1.48
	100	99.55	-0.45	0.31
	150	149.70	-0.20	0.27
	300	301.10	0.37	0.20
TM 1000-8	40	39.86	-0.35	0.50
	45	44.89	0.24	0.65
	50	49.62	-0.76	0.52
	100	100.09	0.09	0.31
	200	201.00	0.50	0.10

Conclusion

Third-party evaluation of a system against its claimed specifications is perhaps the most valuable method of assessing an instrument's true capability. Artel specializes in third-party testing of manual and automated liquid handler performance as the instruments are used in everyday practice. Several makes and models of liquid handlers have been subjected to the highly reliable MVS performance assessment, and this test has become an indispensable element of validation protocols at many regulated laboratories.

In this study, the Artel MVS demonstrated that the performance of the Eppendorf epMotion 5075 automated liquid workstation exceeded Eppendorf's specifications for the accuracy and precision for all pipetting tools and aspirating and dispensing volumes analyzed. The use of this liquid handling device allows users to avoid common errors that can be associated with manual pipetting, thereby reducing the potential need for repeated work and its associated additional costs and time.

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