Real-Time Volume Measurements for Optimizing Liquid Handler Performance

Using the AVENTIX Scarlett 01 Volume Analysis System

Abstract

Automated liquid handling systems routinely require adjustment during installation, preventive maintenance, liquid class development, and process optimization. The challenge is often not making the adjustment but rapidly determining whether the adjustment achieved the desired dispensing performance.

This application note demonstrates how the AVENTIX Scarlett™ 01 Volume Analysis System can be incorporated into an iterative optimization workflow by providing immediate, quantitative measurements of dispense volume directly within the assay plate. Using a Thermo Multidrop Combi dispenser as a demonstration platform, Scarlett identified dispensing channels exceeding a predefined process limit, verified the effect of successive mechanical adjustments, and confirmed when the desired dispensing performance had been achieved.

Although demonstrated using a bulk reagent dispenser, the workflow is broadly applicable to automated liquid handlers used throughout pharmaceutical, biotechnology, and diagnostic laboratories.

Introduction

Automated liquid handlers are routinely adjusted throughout their service life. New instrument installation, preventive maintenance, liquid class development, component replacement, and assay optimization frequently require modification of dispensing parameters to achieve the desired process performance.

While making these adjustments is straightforward, evaluating their effectiveness is often considerably more time-consuming. Traditional verification methods typically evaluate dispensing performance using surrogate liquids or separate verification procedures. While these approaches provide valuable information, they do not directly measure the volume present in the experimental plate.

Scarlett provides immediate, non-contact measurements of liquid volume directly within the assay plate, allowing the effect of each process adjustment to be evaluated using the actual dispensing conditions of interest.

This application note demonstrates how Scarlett measurements can be incorporated into a simple iterative optimization workflow.

Materials and Methods

Dispensing Platform

- Thermo Scientific Multidrop Combi
- Eight-channel dispensing cassette

Test Conditions

- Liquid: Deionized water
- Nominal dispense volume: 150 µL
- Microplate: Greiner Bio-One 655101, 96-well flat-bottom microplate
- Measurement system: Scarlett 01 Volume Analysis System

Process Requirement

For this demonstration, dispense volume was required to remain below 150 µL. This represents a typical process constraint in which excessive liquid volume could interfere with subsequent workflow operations such as mixing, incubation, reagent addition, or plate handling.

Following the initial Scarlett measurement, two dispensing channels producing volumes above the specified process limit were selected for adjustment. Scarlett measurements were repeated following each adjustment to quantify the resulting change in dispense performance.

Iterative Adjustment Guided by Scarlett Real-Time Volume Measurements

Process requirement: Dispense volume must remain **below 150 µL** in each well to satisfy downstream process requirements.

Initial Measurement – All Channels

Tip	Volume (µL)
A	146.24
B	151.06
C	148.73
D	148.63
E	152.60
F	148.49
G	148.65
H	149.10

Initial measurements identified only channels B and E as exceeding the 150 µL process limit.

Iterative Adjustment of Selected Channels

1 Initial Measurement → 2 After First Adjustment → 3 After Second Adjustment

Tip	Volume (µL)
B	151.06
E	152.60

Both channels exceeded the 150 µL process limit.

Tip	Volume (µL)
B	149.97
E	150.21

Channel B is now below 150 µL. Channel E still exceeds the limit.

Tip	Volume (µL)
B	149.31
E	149.60

Both channels are now below the 150 µL process limit.

Adjustment Workflow

1. **Measure** — Measure dispense volumes with Scarlett.
2. **Identify** — Identify channels exceeding the process limit.
3. **Adjust** — Adjust the selected channels.
4. **Verify** — Re-measure with Scarlett to verify the effect.
5. **Repeat** — Repeat until all channels meet the requirement.

Real-time feedback enables efficient, data-driven adjustments.

Red: Above 150 µL (Does not meet requirement) Green: At or below 150 µL (Meets requirement)

Note: Channels A, C, D, F, G, and H were not adjusted during this demonstration.

Results

Scarlett measurements provided immediate quantitative feedback following each process adjustment. Initial measurements identified two dispensing channels exceeding the predefined process limit. Following the first adjustment, one channel met the specified requirement while the second remained slightly above the limit, indicating that additional adjustment was required. After the second adjustment, Scarlett confirmed that both selected channels satisfied the predefined process requirement.

Discussion

The objective of this study was not to evaluate the performance of a specific liquid handling instrument, but rather to demonstrate how direct in-well volume measurements can be incorporated into routine process optimization workflows.

Rather than relying on offline verification experiments, Scarlett provides immediate quantitative feedback following each adjustment. This enables liquid handler settings to be refined iteratively while directly observing the effect of each process change.

Although this demonstration utilized a Thermo Fisher Multidrop Combi dispenser, the workflow is broadly applicable to automated liquid handling platforms including bulk dispensers, automated pipetting systems, reagent dispensers, and robotic liquid handling workstations.

Potential applications include:

- Instrument installation and qualification
- Preventive maintenance verification
- Liquid class optimization
- Method development
- Assay transfer
- Troubleshooting dispensing performance
- Verification following component replacement
- Process optimization during assay development

By measuring dispense volume directly within the experimental plate, Scarlett provides immediate feedback under the actual dispensing conditions used by the laboratory, eliminating the need to infer performance from separate surrogate verification experiments.

Conclusion

This study demonstrated how direct in-well volume measurements can be used to guide iterative optimization of automated liquid handling systems.

Immediate quantitative feedback allowed dispensing adjustments to be evaluated after each process change, enabling rapid confirmation that dispensing performance met predefined process requirements.

By integrating real-time volume measurement directly into optimization workflows, Scarlett extends liquid volume analysis beyond instrument characterization and provides laboratories with a practical tool for process development, troubleshooting, and routine performance optimization.

AVENTIX AB
Gemenskapens Gata 9
Mölndal, 431 53
Sweden

+1 (617)-553 7534
hello@aventix.io