

Using the Thermo Scientific Catalyst Express Robotic Arm to Fully Automate Plate Reformatting on the Thermo Scientific Matrix® PlateMate® 2x3

Emily Caldwell, M.S.
Thermo Fisher Scientific, 22 Friars Drive, Hudson, NH 03051 USA

Key Words

- Thermo Scientific Catalyst Express
- Thermo Scientific Matrix PlateMate 2x3
- Thermo Scientific Matrix D.A.R.T.s Tips
- Plate Reformatting

Abstract

High-throughput research applications require robust liquid handling and plate handling systems. The Thermo Scientific Catalyst Express robotic arm, used in conjunction with the Thermo Scientific Matrix PlateMate 2x3, can increase throughput, maintain consistency and provide walk-away capability for many routine assays. Here we have demonstrated a high-throughput plate reformatting protocol which uses the Catalyst Express robotic arm to shuttle 96- and 384-well plates to and from the deck of the Matrix PlateMate 2x3. This protocol also included Thermo Scientific Matrix D.A.R.T.s® (Disposable Automation Research Tips) tips changing using the Catalyst Express. With the Catalyst Express robotic arm in combination with the Matrix PlateMate 2x3 we were able to reformat 96-well plates into 384- and 1536-well plates with increased efficiency, provide full automation and produce dispenses with high precision and accuracy.

Introduction

The Catalyst Express (see Figure 1), is a five-axis robotic arm with plug and play capability to work in conjunction with Thermo Scientific Matrix liquid handling instruments. The instrument's 360° range of motion allows it to work with multiple instruments to increase efficiency and throughput of a wide range of protocols. The Catalyst Express robotic arm can move labware including microplates, storage blocks, storage tube racks, reagent reservoirs and Matrix D.A.R.T.s tips, according to application needs. The platform of this instrument contains three hotels which can be configured to hold these different types of labware. In the microplate-only configuration, each hotel provides 15 positions. An extension package is available to add up to three additional hotels to the platform, and when incorporated with the Matrix PlateMate 2x3's six-position deck, the Catalyst Express platform can provide additional microplate working spaces to increase efficiency and throughput.

The Matrix PlateMate 2x3 is an automated pipetting station capable of a wide array of applications. When used in conjunction with the Catalyst Express robotic arm, the Matrix PlateMate 2x3 has the capacity to perform high-throughput, walk-away liquid handling applications



Figure 1: Catalyst Express robotic arm integrated with the Matrix PlateMate.

(see Figure 1). The Catalyst Express robotic arm and the Matrix PlateMate 2x3 are both conveniently programmable with the intuitive ControlMate® software interface.

Reformatting plates manually can be a time consuming and tedious task and, due to the small size of the wells, it is not possible to perform liquid handling operations manually with 1536-well plates. We have created fully automated plate reformatting protocols using ControlMate software to control the Catalyst Express robotic arm with the Matrix PlateMate 2x3. In the first protocol, four 96-well plates, each containing different concentrations of tartrazine dye solution, are reformatted into (15) 384-well plates. The second protocol is adapted to reformat (16) 96-well plates containing different colored dye solutions into five 1536-well plates. In these protocols the Catalyst Express robotic arm moves the 96- and 384-well plates between the hotels and the Matrix PlateMate 2x3 deck, as well as performs all Matrix D.A.R.T.s tips changes.

Materials:

1. Distilled Water
2. Tartrazine (Yellow 5) Dye Solution
3. Thermo Scientific Catalyst Express Robotic Arm (Item no. 25563)
4. Thermo Scientific Gripper Tool (Item no. 25563-002)
5. Thermo Scientific Joiner Plate (Item no. 25563-001)
6. Thermo Scientific Matrix PlateMate 2x3 (Item no. 801-10001)
7. Thermo Scientific Matrix Pipetting Head, Air Displacement, 96-Channel, 0.5-30 µl (Item no. 501-20004)
8. Thermo Scientific Matrix WellMate® (Item no. 201-10001)

9. Thermo Scientific Matrix WellMate Stacker Base Unit (Item no. 201-20001)
10. Thermo Scientific Matrix WellMate Stacker Short Chimney (Item no. 501-30006)
11. Thermo Scientific Matrix 384-Well Polystyrene Microplates, Clear, Flat Bottom (Item no. 4310)
12. Tecan Genios Reader
13. Centrifuge
14. Plate Shaker
15. Thermo Scientific Matrix 96-Well Polystyrene Microplates, Clear, Flat Bottom (Item no. 4915)
16. Single Channel Thermo Scientific Matrix Electronic Pipettes (Item no. 1022 & 1024)
17. Thermo Scientific Matrix D.A.R.T.s Tips, 30 μ l (Item no. 5506)

Methods:

(4) 96-Well Plates to (15) 384-Well Plates:

Set-up

1. Tartrazine dye solutions were made in the following concentrations using distilled water: 0.1, 0.2, 0.3 and 0.4%
2. 250 μ l of each dye concentration was added to a 96-well microplate using the Matrix WellMate
3. The tip gripper tool was placed into the first position of Hotel 1, which was configured for eight positions
4. The 96-well plates filled with 0.1, 0.2, 0.3 and 0.4% tartrazine dye were placed into Hotel 1, positions 2, 3, 4 and 5 respectively
5. Nine 384-well plates were filled with 90 μ l of distilled water using the Matrix WellMate and the other six 384-well plates remained empty for dry dispenses
6. 384-well plates were placed into positions 1-15 of Hotel 2, which was configured for 15 microplate positions; the first nine plates were filled with distilled water and the last six plates remained empty
7. Five Matrix D.A.R.T.s tip magazines were placed into Hotel 3, which was configured for five tip positions

Please note: The deck of the Matrix PlateMate 2x3 was empty and there were no tips installed in the pipetting head at the start of the protocol.

ControlMate Protocol (Available upon request):
(see Figure 2)

1. Three Global Values were created, one for each hotel
2. ControlMate software directed the robot arm to insert the tips in Hotel 3, position 5
3. A “Main Loop” was created to move and reformat the plates:
 - a. The first source plate was loaded from position 2 of Hotel 1 and placed in deck position 3
 - b. A “384 Plate Loop” was created to load and reformat the 384-well plates
 - i. The first 3 plates were moved from Hotel 2, positions 1, 2, and 3 and placed onto deck positions 4, 6 and 5, respectively

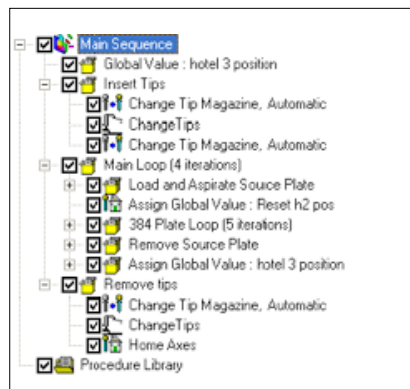


Figure 2: ControlMate protocol for 96- to 384-well plate reformatting.

- ii. The Matrix PlateMate 2x3 pipetting head moved to the source plate and aspirated 10 μ l of dye solution with a pre-air gap of 10 μ l
- iii. The pipetting head moved to position 4 and dispensed all solution into the first quadrant of the 384-well plate
- iv. The aspirate dispense cycles were repeated for the plates in positions 6 and 5
- v. The Catalyst Express robotic arm then moved each 384-well plate back to its position in Hotel 2
- vi. This loop was repeated five times, such that each 384-well plate was moved to the deck to fill the first quadrant with dye solution from the first source plate
- c. After all (15) 384-well plates were filled in the first quadrant with the first reagent; the source plate was moved back to its position in Hotel 1
- d. The robotic arm removed the Matrix D.A.R.T.s tips and replaced them in their position in Hotel 3
4. The “Main Loop” was repeated four times, such that each source plate was placed on the deck, each 384-well plate was filled in its respective quadrant with dye solution from each source plate and the robot arm loaded a new set of tips for each source plate
5. After completion of the protocol, (15) 384-well plates were removed from the hotel
6. To compare the automated process to manual plate reformatting, the four 96-well plates containing different dye solutions were reformatted by hand into three 384-well plates
7. All of the plates were shaken for 5 min. on a plate shaker and then spun down at 1750 rpm for one minute
8. The plates were read with the Tecan Genios Reader set to 412 nm at 5 flashes
9. A standard curve was generated for each concentration of dye by pipetting 5, 10 and 15 μ l of each dye solution, in triplicate and reading the absorbance of the plate
10. Averages, standard deviations, the coefficient of variance (CV) and actual volume dispensed were calculated and recorded for each plate

(16) 96-Well Source Plates to (5) 1536-Well Plates:

Set-up

1. Five different colored dye solutions were made and the (16) 96-well source plates were filled with one of the five colors such that plates 1, 6, 11 and 16 were filled with the first color; 2, 7 and 12 were filled with the next color and so on
2. The filled source plates were placed in order in Hotel 2, configured for 15 microplates, and the 16th source plate was placed in position 2 of Hotel 1
3. The tip gripper tool was placed into the first position of Hotel 1, which was configured for eight positions
4. Five Matrix D.A.R.T.s tip magazines were placed into Hotel 3, which was configured for five tips positions
5. The five empty 1536-well plates were placed on the deck of the Matrix PlateMate 2x3 in positions 1, 2, 3, 4 and 6 (Deck position five was left open to move on and off source plates)

ControlMate Protocol (Available upon request):
(see Figure 3)

1. Two Global Values were created for Hotels 2 and 3
2. The “Hotel 2 Loop” was created with 15 iterations to move the 96-well plates on and off the deck:
 - a. ControlMate software directed the robot arm to insert the tips from position 5 of Hotel 3 into the Matrix PlateMate 2x3 pipetting head
 - b. The robot arm moved the first source plate onto the deck
 - c. A “Home Axes” command was inserted to ensure that the deck was aligned after each iteration of the loop
 - d. The pipetting head moved to the source plate, position five, and aspirated 2 µl of air at the top of the well and then moved into the plate to aspirate 2 µl of dye solution
 - e. The pipetting head moved to the first 1536-well plate, position 1, quadrant 1 and dispensed all
 - f. This was repeated for all five 1536-plates on the deck
 - g. The robot arm returned the first source plate to its position in Hotel 2

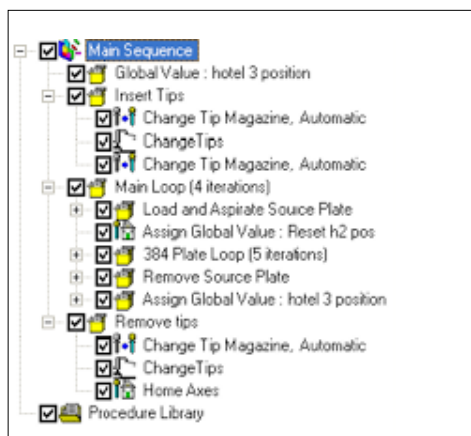


Figure 3: ControlMate protocol for 96- to 1536-well plate reformatting.

- h. The robot arm removed the Matrix D.A.R.T.s tips from the pipetting head and returned them to position 5 of Hotel 3
 - i. This was repeated for all (15) source plates in Hotel 2, each time incrementing to the next quadrant of the 1536-well plates and changing the Matrix D.A.R.T.s tips, one set per each color of dye
3. A “Final Plate” protocol was created where the robot arm moved the 16th source plate from position 2 of Hotel 1 onto the deck
4. The pipetting head performed the same aspirate and dispense sequence as before into the 16th quadrant of all of the 1536-well plates
5. After the ControlMate protocol was finished, all five 1536-well plates were visually inspected for the appropriate dye pattern

Results:

(4) 96-Well Plates to (15) 384-Well Plates:

The dispenses in this experiment were performed both wet, dispensed into 90 µl of distilled water, and dry, dispensed into an empty plate. There was no observed difference in the % CV and calculated error between the two dispense methods, data not shown. All dispenses performed both automatically and manually were neat.

With the automated plate reformatting protocol the % CV was 1.5% or less for all dye concentrations. The calculated error was less than 6.0% for all dispenses with each concentration of dye (see Table 1).

Table1: Average Data for Automated Plate Reformatting

| | | | | |
|-------------------|--------|--------|--------|--------|
| Dye Concentration | 0.10% | 0.20% | 0.30% | 0.40% |
| Absorbance | 0.1924 | 0.4003 | 0.5178 | 0.5988 |
| % CV | 1.5 | 1.1 | 0.7 | 0.9 |
| Volume Dispensed | 9.41 | 10.52 | 9.59 | 9.74 |
| % Error | 5.8 | 5.2 | 4.0 | 2.6 |

When the plate reformatting was performed manually, the calculated CV was less than 10.5%, and the calculated error was 6.2% or less for all dispenses with each concentration of dye (see Table 2).

Table2: Average Data for Automated Plate Reformatting

| | | | | |
|-------------------|--------|--------|--------|--------|
| Dye Concentration | 0.10% | 0.20% | 0.30% | 0.40% |
| Absorbance | 0.2080 | 0.4037 | 0.5192 | 0.6042 |
| % CV | 6.2 | 9.7 | 7.4 | 10.5 |
| Volume Dispensed | 10.30 | 10.62 | 9.63 | 9.84 |
| % Error | 3.0 | 6.2 | 3.7 | 1.6 |

(16) 96-Well Source Plates to (5) 1536-Well Plates:

The dye pattern in the quadrants of the 1536-well plates was visually inspected (see Figure 4). The pattern was consistent across the five 1536-well plates that were reformatted from the (16) 96-well plates. In this protocol, one set of Matrix D.A.R.T.s tips were used for each of the five dye colors and were used at least 3 times. In order to use a new set of Matrix D.A.R.T.s tips in this fully automated process, the hotel extension package, with all three hotels in the Matrix D.A.R.T.s tips configuration, must be added to the deck of the Catalyst Express robotic arm.



Figure 4: 1536-well reformatted plate. Inset is 4-well x 4-well close-up of dye dispense pattern.

Conclusion

Through this experiment we have shown that the Catalyst Express robotic arm, in conjunction with the Matrix PlateMate 2x3, successfully automates plate reformatting, eliminating human induced variability and performing dispenses with high precision and accuracy. The Catalyst Express robotic arm and the Matrix PlateMate 2x3 ensure that solution is dispensed into the proper well of each microplate. The instruments are also programmed to track all plates so the user will know the location of source plates, reformatted plates and reagents within the automated system. Using the Catalyst Express robotic arm in combination with Matrix liquid handling instruments provides opportunities to fully automate a wide range of laboratory applications.

Acknowledgements: I would like to thank Tal Murthy, Ph.D. and Kiara Williams as well as Maryellen Margossian and Brandie Clarke for their document editing and contributions. I would also like to thank Brian Curtis for his assistance with the Catalyst Express robotic arm functions and ControlMate programming. This work was performed at the Thermo Fisher Scientific facility in Hudson, New Hampshire, USA.

In addition to these offices, Thermo Fisher Scientific maintains a network of representative organizations throughout the world.

North America
+1 800 345 0206
matrix.info@thermofisher.com

Europe
+44 (0) 161 486 2110
matrix.eu.info@thermofisher.com

Asia
matrix.ap.info@thermofisher.com

www.thermo.com/matrix

© 2008 Thermo Fisher Scientific Inc. All rights reserved. All trademarks are the property of Thermo Fisher Scientific Inc. and its subsidiaries.

Specifications, terms and pricing are subject to change. Not all products are available in all countries. Please consult your local sales representative for details.