

MATRIX **PLATEMATE 2x3**

User Manual



Thermo
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1 Introduction

The **Thermo Scientific Matrix PlateMate™ 2x3** Liquid Transfer Device is a member of the **Thermo Scientific Matrix PlateMate** line with (8) interchangeable air and positive displacement pipetting systems. A small footprint and unprecedented operator safety mechanisms make it the instrument of choice for a wide range of liquid-handling applications. This platform offers all the tools and flexibility for assay development and low to medium throughput. The device can easily be implemented as a core pipetting system in any integrated robotic environment.

The **Thermo Scientific Matrix PlateMate 2x3** combines a stepper-motor controlled stage (X and Y motion) with a vertically adjustable pipetting head, enabling reliable tip access into all standard lab ware (96 – 1536). It also has the added capability to perform serial dilutions in both portrait or landscape layouts (96 and 384 well plates).

With user-friendly software running under MS-Windows (**ControlMate** PlateMate 2xY ver. 1.1.2 or newer), operators in chemical, biological, physical and in-vitro medical laboratories can quickly and easily customize specific laboratory protocols.

1.1 System Features

The **Thermo Scientific Matrix PlateMate 2x3** base unit provides a universal platform upon which a flexible automated workstation is built. This platform supports a deck offering simultaneous vessel placement for up to six vessels in any user-definable position, deep or shallow well plates, any of the standard interchangeable pipetting heads, and a host of other system accessories.



Figure 1: Thermo Scientific Matrix PlateMate 2x3 System

A base unit includes these following standard features:

- A variable-position (portrait or landscape) microplate deck for easy plate or reservoir placement onto the device.
- High-resolution linear plate movement allows accurate ($\pm 0.05\text{mm}$) microplate positioning of 96, 384, 864, and 1536 well plates.
- Two power-interrupt safety sensors guard access to the pipetting area:
 - ❑ Sliding door that stops vertical pipettor movement if it is opened during an operation
 - ❑ Front light curtain that stops vertical pipettor movement if it detects motion (e.g., an operator's hand) entering the pipetting area during an operation.
- Stepper motors provide operator safety and prevent instrument damage.
- Two peristaltic pumps with integrated liquid level detection enable onboard reagent or wash fluid replenishment.
- One vacuum pump provides waste fluid removal from the tip wash station, which reduces cycle time and sample carryover.
- (8) Interchangeable pipetting heads are a powerful feature that provides optimal performance and flexibility for either 96 or 384 channel pipetting applications. Pipetting heads can be easily replaced as needed depending on the plate format or volume range requirements.
- One switched 24 volt DC supply outlets for additional externally controlled devices.

Efficient pipette tip replacement

Matrix D.A.R.Ts™ (Disposable Automated Research Tips) are compatible with the **Thermo Scientific Matrix PlateMate 2x3** pipetting heads. Tips held in the disposable magazine are placed on the device and seal directly against a silicone pad. This forms a definitive seal without the use of conventional tip fittings or O-rings. In addition to providing a cleaner seal that presents less opportunity for contamination, this method provides the added benefit of ensuring uniform tip height across all 96/384 pipette tips, which facilitates consistent drop delivery onto flat-bottom microplate surfaces. Filter tip options are available for disposable tips.

Serial dilution feature

To further expand the versatility of the **Thermo Scientific Matrix PlateMate 2x3**, Matrix has designed the system to support 8-, 12-, 16-, or 24- channel serial dilution applications. This is accomplished by using a dedicated 8-, 12-, 16-, or 24-channel tip magazine. The instrument's discrete x/y advancement design allows for incremental plate movement needed to accomplish row-by-row or column by column dilutions directly on the **Thermo Scientific Matrix PlateMate 2x3**.

Volumetric calibration

Thermo Scientific Matrix PlateMate 2x3 systems are factory calibrated using distilled water at room temperature (20°C). In cases where liquids of varying specific gravity are to be pipetted, the instrument can be recalibrated accordingly. This feature ensures accurate liquid delivery no matter what fluids are being dispensed. Calibration for specific liquids can be performed quickly in the lab. Many calibration settings can be stored in memory and applied when needed. Volume calibration is a feature found on all **Thermo Scientific Matrix** liquid handling systems.

1.2 About this Manual

To use your new **Thermo Scientific Matrix PlateMate 2x3** properly and safely, read this Operation Manual. Due to changing technologies and product enhancements, this manual may be changed without notice. However, if you want to receive product updates on the **Thermo Scientific Matrix PlateMate 2x3**, please contact your local sales representative.

We have made every effort to ensure that this document is accurate and comprehensive. However, if you discover an error or omission, please contact your local distributor or Thermo Fisher Scientific, Hudson, New Hampshire, immediately, at the address on the cover of this manual.

Thermo Fisher Scientific will not be responsible for any damage or claims of loss suffered as a result of use of this equipment in any application or in any manner other than that for which it was originally and expressly designed.

Any transfer of all or any part of this manual to a third party without permission is prohibited.

1.3 Manual Conventions

References to other sections in the manual are shown in italic text.	See <i>Chapter 3, ControlMate Software</i> , for software installation and operation.
Software buttons and menu selections are shown in bold text.	Select “Pipettor and tips”. Click “Start”.
Notes provide additional information and are shown in shaded boxes	Note: Passwords are case sensitive.
Important notes provide essential information and are shown in shaded boxes	IMPORTANT: Use <i>All</i> with blowout if a piston reset is required.
Cautions alert you to conditions that can cause equipment damage and are shown in shaded boxes.	CAUTION! Do not restrict movement of the microplate carriage.
Warnings alert you to conditions that can cause personal injury and are shown in shaded boxes next to the warning icon.	 WARNING! Do not use a power cord that is frayed or cut.

2 System Overview

2.1 General Description

The **Thermo Scientific Matrix PlateMate 2x3** Automated Microplate Pipetting System is a flexible, multichannel, automated, pipetting workstation, capable of performing various routine liquid manipulations. In either the 96-channel or 384 channel mode, operations such as reagent addition, serial dilution, microplate replication and sample dilution can be easily accommodated.

Using air displacement technology and Matrix's filtered or non-filtered disposable automation research tips (D.A.R.Ts), the **Thermo Scientific Matrix PlateMate 2x3** provides fast, flexible and precise automated liquid delivery while ensuring zero carryover, thereby greatly reducing the risk of contamination. The **Thermo Scientific Matrix PlateMate 2x3** is also compatible with a selection of positive displacement (syringe-based) pipetting heads in 96 and 384 well format for liquid handling tasks that involve viscous solutions or low volume pipetting.

2.2 Instrumentation

2.2.1 System Configuration

This section summarizes the standard components in the base system.

The Thermo Scientific Matrix PlateMate 2x3 Base Units:

Two base unit models are available. Both models share the following list of standard features:

- flexible six-position deck
- high-resolution linear microplate movement
- two peristaltic pumps (stepper-motor controlled) with integrated non-contact liquid level detection
- one vacuum pump
- one 24VDC input/output switches
- universal operating voltage (100 – 240VAC)
- bar-code reading capability (using the barcode reader accessory)
- Stepper motors for plate positioning (supports 96, 384, 864, and 1536 well plates; also supports deep or shallow wells)
- Keyboard unit for manual control
- **ControlMate** Windows-based PC interface software for sequence-based program creation and editing, plus OLE option for robotic integration



The Standard Base Unit

The standard base unit is designed with operator safety as a first priority. This model features an integrated light curtain safety shield as standard. An operator's hand activates an interrupt system that temporarily pauses all movement ensuring unparalleled operator safety. Once the obstruction is removed the device is allowed to resume processing.

Figure 2-1: Thermo Scientific Matrix PlateMate 2x3 Standard Base Unit
(Cat. No. 801-10001)



The Robotic-Friendly Base Unit

The robotic-friendly base unit has been designed for the purpose of robotic integration and access. This base unit configuration is not equipped with a light curtain interrupt system and has been modified for easy front or side access by a robotic arm.

Figure 2-2: Thermo Scientific Matrix PlateMate 2x3 Robotic-Friendly Base Unit
(Cat. No. 801-10005)

2.2.2

2.2.3 System Components

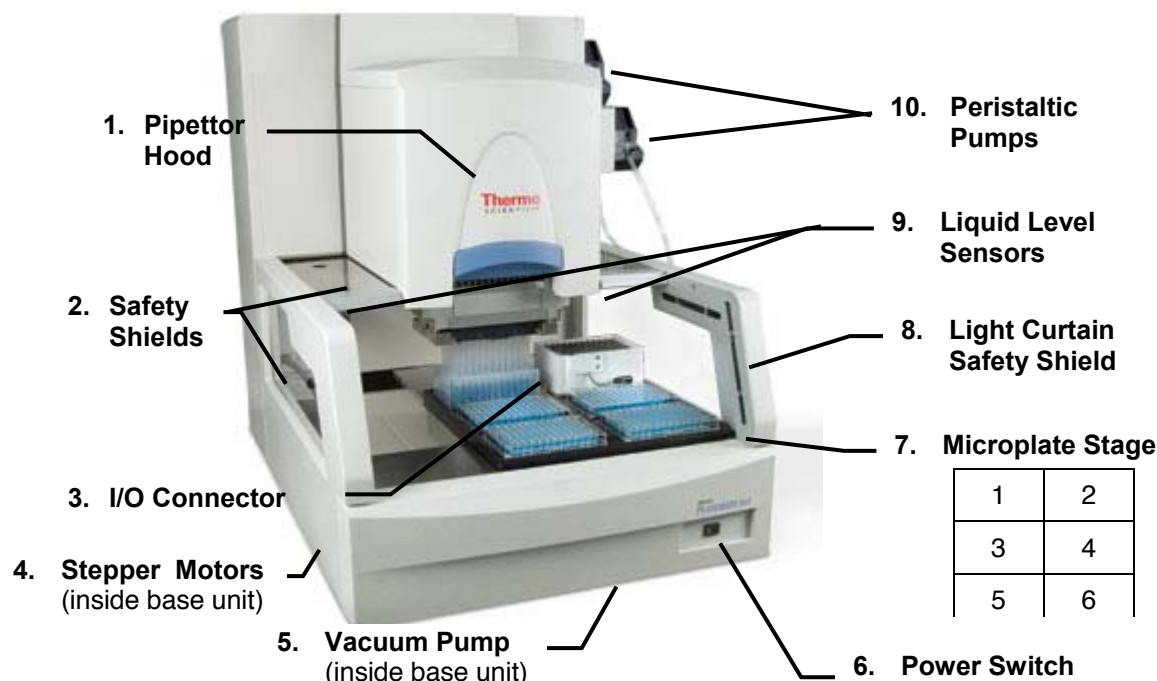


Figure 2-3: Thermo Scientific Matrix PlateMate 2x3 Components

Main System Components

Base Unit: Contains two stepper motors that provide X and Y motion of the 6-position microplate stage. The motors are software-controlled through the PC or manual keyboard. This component also contains all of the electronic controls.

The Base Unit includes the following components:
(Refer to Figure 2-3)

1. **Pipettor Hood:** Houses pipettor head and tips magazine. Front panel can be raised to allow access to the internal components.
2. **Safety Shields:** Plastic covers on both sides of the instrument provide safety to the operator and reduce possible contamination of the work area.
3. **I/O Connector:** One connector on either side of the deck allow for additional externally operated devices. Power to the connector is software-controlled.
4. **Stepper motors:** Stepper motors move the 6-position microplate deck vertically and horizontally.
5. **Vacuum pump:** Removes waste fluid from the tip wash station.
6. **Power switch:** Rocker switch turns **Thermo Scientific Matrix PlateMate 2x3** on or off.

- 7. 6-Position Microplate deck:** Microplate deck contains six microplate positions. Platform is SilverStone® (PTFE®) coated for easy cleaning. Supports 96, 384, 864, and 1536 well plates; also supports deep or shallow wells). Supports a variety of standard SBS conforming labware (microwell plates and reservoirs):

Stage 1: microplate, deep well block, tube rack, or reagent reservoir

Stage 2: microplate, deep well block, tube rack, reagent reservoir, or tip wash station (Stage 2 only)

Stage 3: microplate, deep well block, tube rack, manually filled reservoir, vacuum manifold, or sepraseal piercing manifold

Stage 4: microplate, deep well block, tube rack, manually filled reservoir, or sepraseal piercing manifold

Stage 5: microplate, deep well block, tube rack, manually filled reservoir, or sepraseal piercing manifold

Stage 6: microplate, deep well block, tube rack, manually filled reservoir, or sepraseal piercing manifold

- 8. Light curtain safety shield:** Safety sensors cover the front entry to the instrument. If an operator attempts to access the pipetting area during an operation, the instrument automatically stops to prevent possible injury.

- 9. Liquid-level sensors:** Two non-contact, liquid-level sensors monitor liquid levels in the reagent reservoir during reagent filling.

- 10. Peristaltic pumps:** Two pumps, mounted on the side of the base unit, supply fluid to the reagent reservoir or tip wash station on the microplate deck. Quick-release handles allow for quick and easy tube replacement.

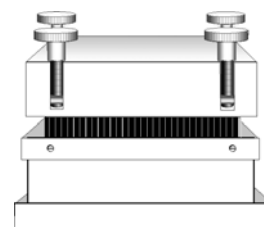
- 11. Keypad:** Manual keypad provides direct control of the microplate deck for basic microplate positioning or troubleshooting.



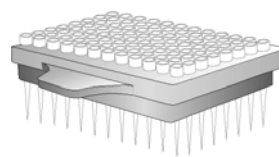
- 12. ControlMate Software (not shown):** Windows-based PC interface software for sequence-based program creation and editing, plus OLE option for robotic integration.

Other System Components:

Pipettor Head: Air and positive displacement interchangeable pipetting heads that can be easily inserted into or removed from the base unit. Air displacement pipetting heads contain a silicone gasket that forms an airtight seal with tips in the tips magazine. Pipettor heads are available with 96 and 384 channels.



Tips Magazine: Aluminum or plastic frame that holds 96 or 384 pipette tips. Disposable tips magazines (D.A.R.T.s) can be used with the **Thermo Scientific Matrix PlateMate 2x3**. Tips magazines with PTFE-coated, stainless steel tips and partial row tips are also available.

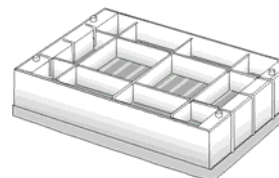


Tips transfer tool (not shown): Transfers D.A.R.T.s tips from a container to the tips magazine.

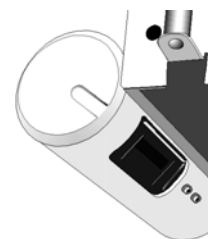
Tip wash station: Used for washing disposable or PTFE-coated stainless steel pipet tips, both interior and exterior walls. It is mounted on a microplate stage and connects to the buffer and waste lines; liquid-level sensor prevents overflow. Tip wash stations are available in 96 and 384 format tall and standard height versions.



Reagent reservoir: Reagent vessel for dispensing limited volume of reagent. Automatic fill reservoir is mounted on a microplate stage. A separate buffer line connects to the peristaltic pump and buffer bottle. The reservoir provides a continuous supply of reagent; liquid-level sensor prevents overflow.



Barcode reader: Optional component that is mounted to the side of the pipettor hood and reads the barcode label on the side of a microplate when it is moved in position for pipetting.



The barcode reader supports the following barcode types:

- ◆ Code39
- ◆ ITF
- ◆ Industrial 2 of 5
- ◆ Codabar
- ◆ EAN/UPC (A.E)
- ◆ CDOE 128
- ◆ COOP 2 of 5
- ◆ Read Error
- ◆ CODE93

Vacuum Manifold: An optional accessory that can be used on stage position 3 to perform filtration procedures on the Thermo Scientific Matrix PlateMate 2x3 deck. The manifold accessory kit includes (5) plate lifters to accommodate for the height restrictions when using short 96 or 384 format D.A.R.T.s. The manifold is compatible with 96 and 384 filtration labware.

Sepraseal Piercing Manifold: An optional deck accessory that allows for the simultaneous piercing of 96 seprasealed storage tubes. The piercing manifold is compatible with 1.4mL, 0.7mL, and 0.5mL Tubes. Separate piercing head is required for sepraseal piercing applications.

2.2.4 Pre-installation Requirements

The **Thermo Scientific Matrix PlateMate 2x3**, with its compact size and small footprint requires little bench space. However, additional bench space is needed for reagents, buffers, waste container, and computer system.

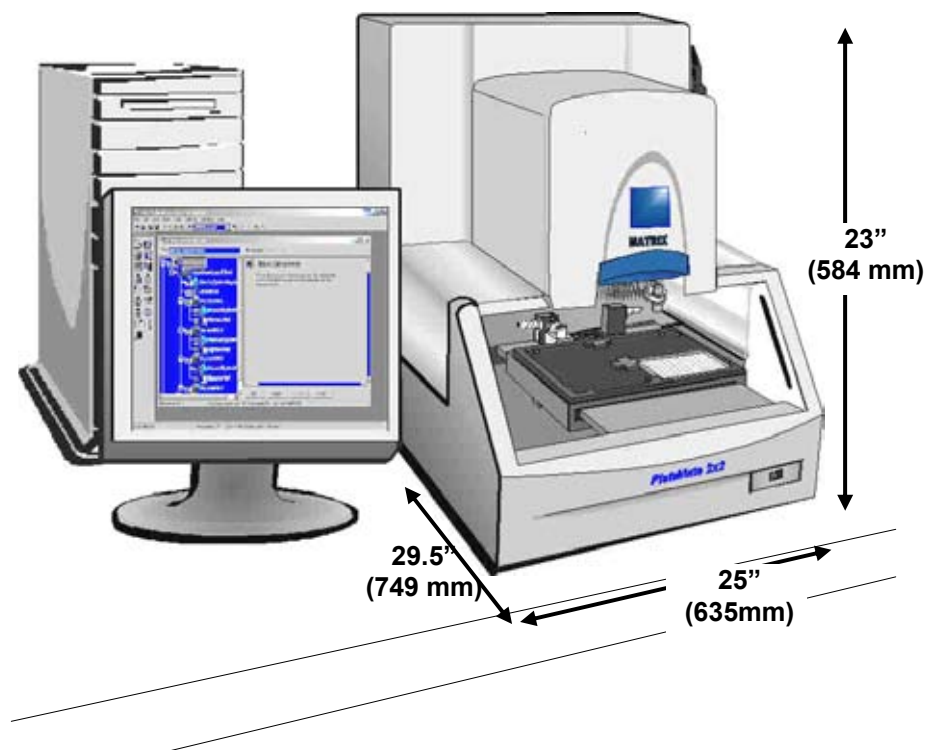


Figure 2-4: Selecting the Proper Location

Consider the following requirements when selecting a place for your system:

- Flat surface capable of holding 110 lbs (50 kg) plus weight of computer
- Ventilation space: 23 in. (584 mm) height + 29.5 in (749 mm) depth + 25 in (635 mm) width (space around instrument)
- Bench space on left side for computer and monitor (6.5 ft. serial cable is provided)
- Bench space on right side for reagent supplies (approx. 1 ft.; 3 ft. tubing provided)
- Grounded wall outlet supporting 110/220 VAC (standard outlet for instrument, plus outlets for PC system)
- PC system for **ControlMate** software

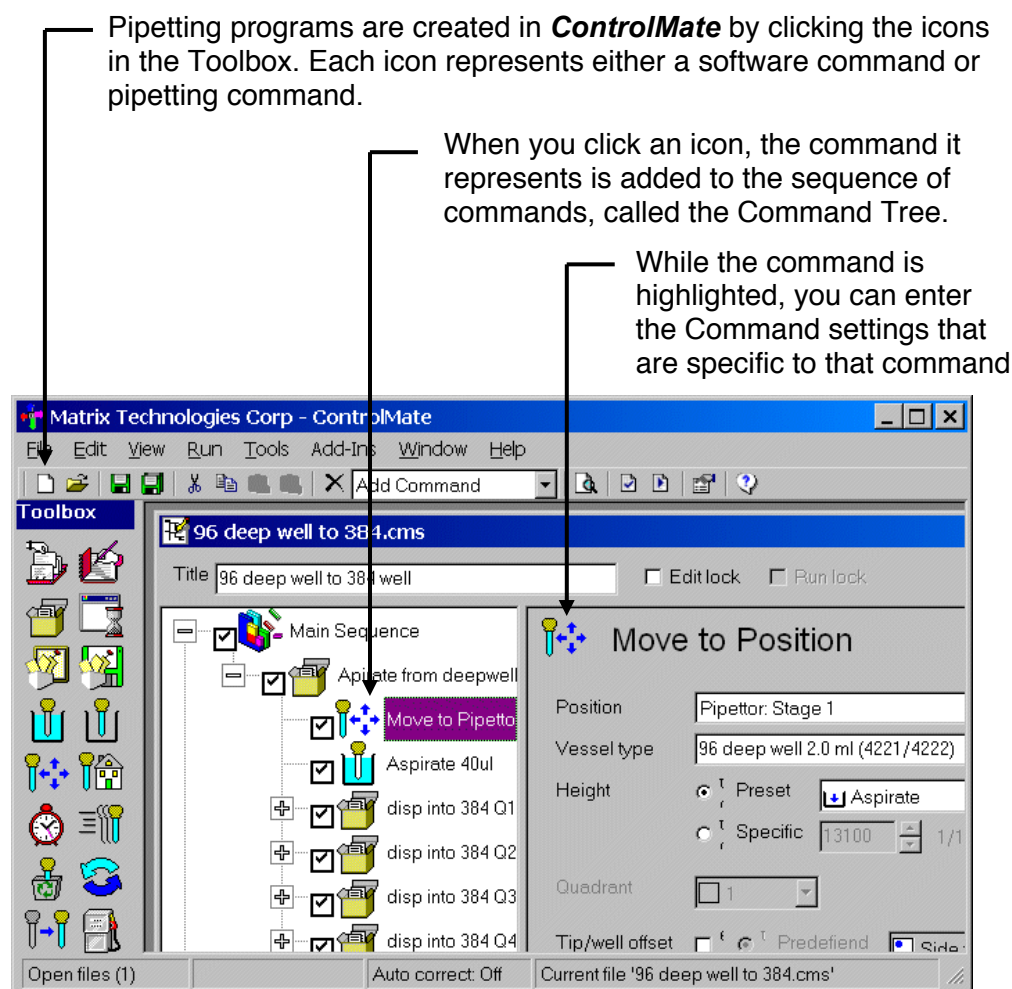
2.3 Software Interface (*ControlMate*)

2.3.1 Overview

ControlMate is a Windows-based PC application that provides a graphical programming interface for creating and executing device and module control programs. The commands can be logically structured, according to the control requirements. The application provides a standard method by which control programs are created; the configuration defines the device module in use.

Note: See *Chapter 3, ControlMate Software*, for installation and operating instructions.

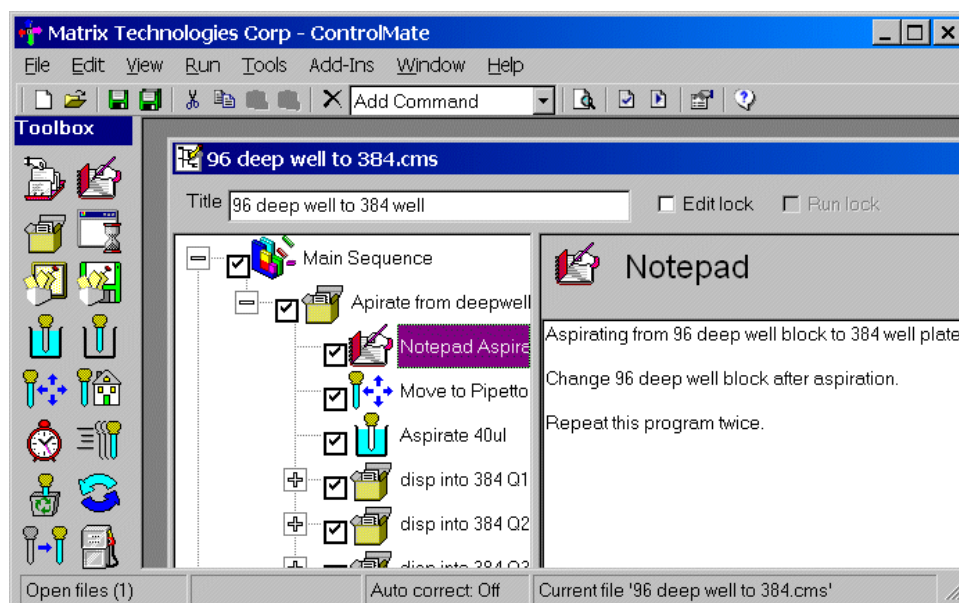
2.3.2 Creating a Program



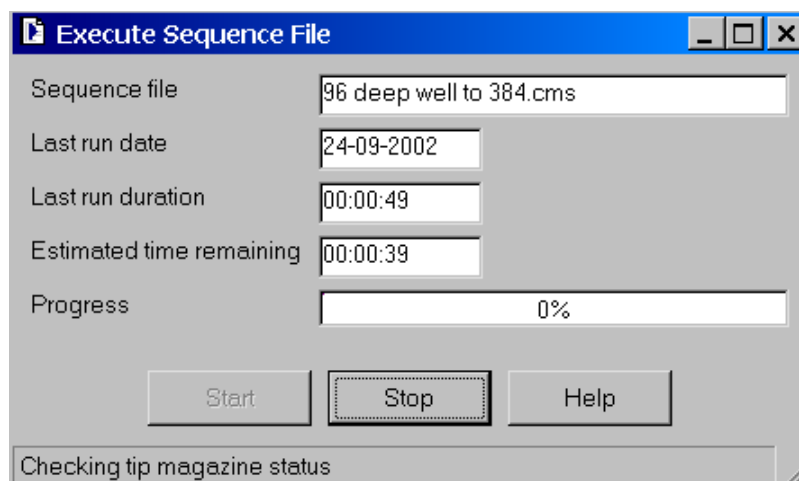
After you create a program, you can validate it in **ControlMate** before running it on the **Thermo Scientific Matrix PlateMate 2x3**.

2.3.3 Running a Program

Before running a program, you can check for setup instructions or last-minute notes in the Notepad. This feature is ideal for documenting any assumptions that are made during the creation of a pipetting program. It serves as a reference for the user when the program is implemented.



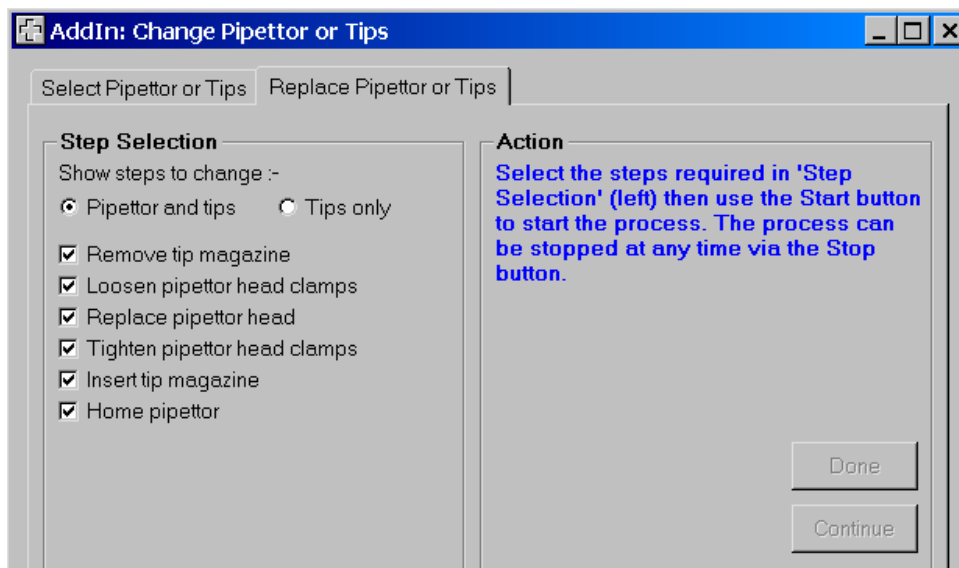
When you are ready, you can run the pipetting sequence.



At any time during the pipetting sequence, you can click “Stop” to interrupt the program.

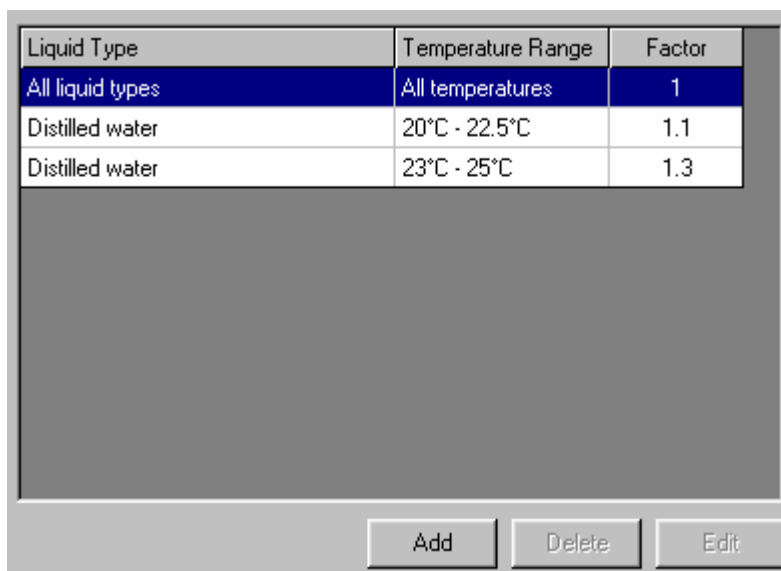
2.3.4 Changing *Thermo Scientific MatrixPlateMate 2x3* Components

ControlMate software also provides step-by-step instructions to change **Thermo Scientific PlateMate 2x3** components, such as pipetting tips or pipetting heads.



2.3.5 Calibrating Liquids

For liquids that require an accuracy adjustment during volume dispensing, you can determine the calibration factor that adjusts to the specific gravity of the liquid. The Volumetric Calculation option in **ControlMate** adjusts the movement of the piston motor to improve pipetting accuracy for specified liquids.



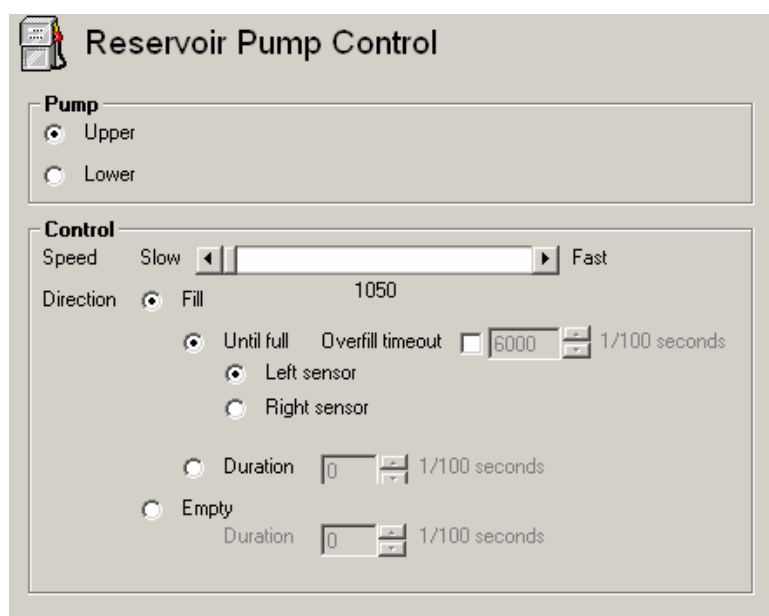
2.3.6 Controlling Reservoir Pumps

The reservoir pumps can be used to fill reservoir vessels and can also provide finite control over the speed at which the liquid flows in either direction (fill or empty). Typically there are two pumps and their respective outlets available; these are positioned on either side of the pipetting head.

The pumps can be controlled by either filling until a reservoir liquid level sensor is activated or by filling for a fixed length of time. Using a sensor rather than a fixed duration to control pump motor activation will reduce the operating time of a process if the reservoir is to be used many times during a run.

The **Overfill timeout** option serves as a backup to the pump sensor. The pump shuts off after the specified time (default is 60 seconds) in case the non-contact sensor fails.

The “Empty” option reverses the direction of the pump and returns any liquid in the tubing to its container. The “Duration” (in seconds) depends on the length of the tubing.



The screenshot shows the 'Reservoir Pump Control' window. It has a title bar with a small icon and the text 'Reservoir Pump Control'. Below the title bar, there are two main sections: 'Pump' and 'Control'.

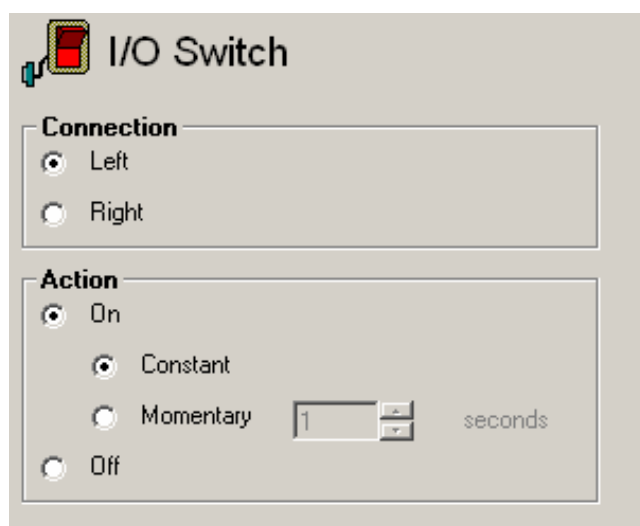
The 'Pump' section contains two radio buttons: 'Upper' (selected) and 'Lower'.

The 'Control' section contains several controls:

- Speed:** A slider control with 'Slow' on the left and 'Fast' on the right. The current value is 1050.
- Direction:** A radio button labeled 'Fill' (selected).
- Until full:** A radio button (selected) with an 'Overfill timeout' field set to 6000 and a unit of 1/100 seconds.
- Sensors:** Two radio buttons: 'Left sensor' (selected) and 'Right sensor'.
- Duration:** A radio button (unselected) with a 'Duration' field set to 0 and a unit of 1/100 seconds.
- Empty:** A radio button (unselected) with a 'Duration' field set to 0 and a unit of 1/100 seconds.

2.3.7 Connecting to External Devices

One connector exists in the rear center of the deck by which additional externally operated devices can be attached. This command will control the activation of the DC supply to the connectors. This supply can be switched on or off and also constant or momentarily.



The image shows a control panel titled "I/O Switch" with a red switch icon. It contains two sections: "Connection" and "Action".

Connection

- ☒ Left
- ☐ Right

Action

- ☒ On
- ☒ Constant
- ☐ Momentary seconds
- ☐ Off

2.4 Overview of Operation

2.4.1 Laboratory Application

Some of the possible laboratory applications for the **Thermo Scientific Matrix PlateMate 2x3** are outlined below:

- Preparation for enzyme immunoassays (EIA):
 - ◆ Enzyme immunoassays in the ultra-micro-liter volume range
 - ◆ Rotavirus antigen, antibodies against toxoplasma gondii, antibodies against adenoviruses
 - ◆ Double antibody sandwich assay for determining AFP, TSH, HGH, IgE, Lipid A antibodies, DNA antibodies, potato viruses, antibodies against bovine leucosis viruses
- Preparation for agglutination reactions with subsequent quantitative photometric analyses:
 - ◆ Blood group determinations in the ABO and Rh systems
 - ◆ Coombs-reactive antibodies
 - ◆ Latex agglutination tests
- Application in cell cultivation:
 - ◆ Hybridoma screening for working with cell cultures
 - ◆ Cell seeds, cell cloning
 - ◆ Changing the nutrient medium of cell cultures
- Dosing the scintillation solution in microplate LSC
- Dosing and transfer steps in PCR
- Simple reagent (liquid) addition
- Serial dilution across 8/12 or 16/24 columns for sensitivity analysis
- Plate to plate replication
- Automating IC-50 assays

2.4.2 General Operation

The following outline summarizes the tasks you would perform for a pipetting operation. Not all of the tasks may be needed, depending on the instrument setup and the pipetting program you use.

1. Start **ControlMate**
2. Start **Thermo Scientific Matrix PlateMate 2x3**
3. Set up **Thermo Scientific Matrix PlateMate 2x3**
 - ❑ Change pipettor head
 - ❑ Change tips
 - ❑ Attach Reagent Reservoir
 - ❑ Attach Tip Wash Station
4. Run pipetting program
5. Shut down **Thermo Scientific Matrix PlateMate 2x3**

Each task is described in more detail in *Section 4, System Operation*.

2.4.3 Device Precision

The **Thermo Scientific Matrix PlateMate 2x3** was tested for precision at volumes ranging from 0.5 μl to 5.0 μl . The results are summarized below. To review the raw data, go to *Appendix C, Precision Data*.

Table 2-1: Device Precision

Volume	Plate average	Plate SD	Plate C.V.
0.5 μl into a dry 384 well plate	1303.5	95.54	7.3%
1.0 μl into a dry 384 well plate	1996.5	105.06	5.26%
2.5 μl into a wet 384 well plate	4877.8	208.78	4.28%
5.0 μl into a wet 384 well plate	10073	253.67	2.52%

2.5 Specifications

2.5.1 System Specifications

Instrument Dimensions

Base unit weight	190 pounds (85.5 kilograms)	
Dimensions	Height	23 inches (584 millimeters)
	Depth:	29.5 inches (749 millimeters)
	Width:	25 inches (635 millimeters)

Liquid Capacity

Pipetting Volume	96-Channel Head	384-Channel Head
	Tip 1: 0.5 μ l – 30.0 μ l Tip 2: 5.0 μ l – 300.0 μ l	Tip 3: 0.5 μ l – 30.0 μ l Tip 4: 1.0 μ l – 100 μ l
Plate Access	96, 384, 864, 1536 shallow wells	384 & 1536 shallow wells
	96 deep well	384 deep well
Reagent Reservoirs	96 channel 100 mL (with automatic fluid replenishment and level detection)	384 channel 50 mL
Tip Wash Station	96 channel (tall and standard height)	384 channel (tall and standard height)

System Control

Keypad control	Liquid crystal touch-panel. Dialog-type input for programming mode operations.
PC control	PC: 64 MB RAM, 400 MHz processor, Windows platform, with a serial port.
	Software: <i>Control/Mate</i> Software, version 1.06 or later
I/O Switch	Input/Output Switch for External Devices

24 VDC, 0.4 amp/switch (0.7 amp total)

Environmental requirements

Operational environment:	Indoor use only
Temperature:	+15°C ~ +40° C for operation
Relative Humidity:	<85% at +30° C.
Altitude:	Up to 2,000 meters or 1.5+ miles
Supply voltage fluctuations:	AC 100 ~ 240 V ±10%
Installation category:	II
Pollution degree:	2
Power requirements:	AC 100 ~ 240 V ±10%, 50/60Hz, 100VA
Fuse:	Time-lag type. Voltage: 250V, 2A

2.5.2 Accuracy and Precision

Catalog #	Channels	Volume Range	Air or Positive Pipetting Technology	Accuracy	Precision
501-20004	96	0.5-30 μ l	Air	+/- 2.0% or 0.15 μ l	1.5% or 0.1 μ l
501-20001	96	5.0- 300 μ l	Air	+/- 2.0% or 1.0 μ l	1.5% or 0.75 μ l
501-20002	384	0.5-30 μ l	Air	+/- 2.0% or 0.15 μ l	1.5% or 0.1 μ l
501-20005	384	1.0- 100 μ l	Air	+/- 2.0% or 0.5 μ l	1.5% or 0.25 μ l
501-102810	96	0.1-50 μ l	Positive Displacement, Stainless Steel, PTFE	+/- 2.5% or 0.01 μ l	1.5% or 0.02 μ l
501-102811	96	0.1-50 μ l	Positive Displacement, Duraflex	+/- 2.5% or 0.01 μ l	1.5% or 0.02 μ l
501-102890	384	0.1-50 μ l	Positive Displacement, Stainless Steel PTFE	+/- 2.5% or 0.01 μ l	1.5% or 0.02 μ l
501-102891	384	0.1-50 μ l	Positive Displacement, Duraflex	+/- 2.5% or 0.01 μ l	1.5% or 0.02 μ l

Table 2-2: Thermo Scientific Matrix PlateMate 2x3 Accuracy and Precision

2.6 Hazards and Precautions

There are no known hazards associated with the **Thermo Scientific Matrix PlateMate 2x3** when it is operated in accordance with the instructions in this manual. However, you should be aware of situations that can result in serious injury.

Note: Do not perform troubleshooting procedures on the internal components unless instructed by Matrix Technologies service personnel.

2.6.1 Warnings



The following warnings describe conditions or situations that can cause personal injury. Throughout the manual, warnings will be marked with the Warning icon in the left margin.

- Ensure that the power plug is connected to a power receptacle that provides voltage and current specified for the device. Use of incompatible line power can cause shock and fire hazard.
- Never use a two-prong adapter or connect the device into a two-prong receptacle. Use of a two-prong receptacle disables the electrical grounding and creates a severe shock hazard. Always plug the device directly into a three-prong receptacle with a functional ground.
- Do not use a power cord that is frayed or cut. Do not kink or strain the power cord. Use of a damaged power cord can cause shock and fire hazard.
- Never plug, unplug, or otherwise touch the power cord when your hands are wet. Contact with the cord can cause severe shock hazard.
- If you notice smoke or unusual odor or noise coming from the instrument, turn it off immediately, then unplug the power cord. Do not use the instrument until it has been serviced and inspected by Thermo Fisher Scientific or authorized service representative.
- Always turn off the power switch and unplug the power cord when servicing the device. Contact with internal components or other components connected to the line power can cause severe shock hazard. Perform only service procedures that are described in the manual or authorized by Thermo Fisher Scientific service personnel.
- Do not allow tools, objects or liquids to enter the instrument through ventilation slots or other openings. Contact with electrical or other internal components can cause severe shock hazard, fire hazard, or instrument malfunction. If a hazardous condition occurs, disconnect the instrument from the line power immediately.
- Keep hands away from moving parts (e.g., tips magazine mechanism and the peristaltic pump). Personal injury may result. Warning symbols on the device indicate areas of potential personal injury.

2.6.2 Cautions

The following cautions describe conditions or situations that can cause damage to the instrument.

- Do not install or operate unit in extreme environmental conditions (e.g., direct sunlight, extreme temperature or humidity, or restricted ventilation). Refer to installation instructions for proper environmental conditions.
- When unpacking or transporting the Thermo Scientific Matrix PlateMate 2x3, always support the base to prevent damage to the instrument.
- The Thermo Scientific Matrix PlateMate 2x3 is designed for use on a bench top. Set up the instrument on a sturdy bench or table that is capable of holding its weight and remains stable during its operation.
- Always turn off the power and unplug the power transformer before cleaning the instrument. Fluid seepage can damage internal components.
- When disconnecting the power plug from the power receptacle, grip the plug itself, not the cord. Pulling on the cord can damage the cord, exposing the electrical wires, and cause a shock hazard.
- Use replacement fuses that conform to the current rating and specification. Use of improper fuses, or short-circuiting the fuse holders can cause fire hazard or damage the instrument.
- Do not exert undue pressure on the slide rails.
- Do not restrict movement of microplate carriage.
- Never load an empty tips magazine, as this may damage the pistons.
- Use only accessories and replacement parts provided by, or recommended by Thermo Fisher Scientific. Use of improper accessories and parts can damage the instrument.
- Do not clean the instrument with abrasive cleansers, flammable or caustic solutions, or solvents (such as paint thinners or acetone). Use of such cleansers will damage the instrument housing, keyboard, and display.
- The following components contact liquid directly; therefore, use only liquids that are compatible with these components:
 - Polypropylene tips
 - PMMA or PTFE vessels
 - Silicone hoses

- Avoid using acids, bases and organic solvents in the instrument, they will reduce the life of the piston-gasket system and can damage other critical components. Also note that indirect contact can occur between the liquid and the piston-gasket system through aerosols. Pistons are stainless steel, and gaskets are polyethylene. Tips and the tip magazine can be placed in the tip rack and be steam-autoclaved at 121 °C.

Note: Failure to observe these cautions may invalidate your warranty.

If you have questions about any aspect of operating the **Thermo Scientific Matrix PlateMate 2x3** safely, please contact Thermo Fisher Scientific.

3 ControlMate™ Software

ControlMate is a Windows-based application that provides a graphical user interface for creating and running pipetting programs. From this application you can create and run a variety of pipetting operations, from repetitive liquid transfers to complex pipetting sequences.

Because the **ControlMate** software is tightly integrated with the **Thermo Scientific Matrix PlateMate 2x3** instrumentation, you can control all **Matrix PlateMate 2x3** functions from the software, such as: changing tips and pipettor heads, or fine-tuning plate movements to handle delicate pipetting operations (e.g., transferring or mixing liquids in 1536 microwells).

This chapter covers software installation and setup. It also provides basic steps to understand and use the software, as well as a reference section of all **ControlMate** functions. Refer to the following chapters for instrument procedures using **ControlMate**:

Chapter 4, System Operation: Includes software steps used in starting the instrument, changing pipettor tips or pipettor heads, setting up reagent reservoir and tip wash station, and creating and running common pipetting sequences.

Chapter 6, Pipetting Techniques: Includes software-controlled calibration sequences.

3.1 Minimum System Requirements

- Computer configuration requirements:
 - ❑ Pentium PC, 400 MHz Processor, 64 Mb RAM
 - ❑ Microsoft Windows 95/98/NT
- Computer interface requirements:
 - ❑ Serial RS-232C, 16 byte FIFO memory (UART16550AFN)
 - ❑ 9600 bps
 - ❑ 7 data bits
 - ❑ 1 stop bits
 - ❑ Even parity

NOTE: For Windows NT, **ControlMate** Service Pack 6.0 or higher is required.

- ❑ CD-ROM drive for installation
- ❑ VGA or Super VGA video display card
- ❑ Microsoft- or IBM PS/2-compatible mouse

Note: For details on computer interface connection, see *Section A, Host PC Communication*.

3.2 Installation

3.2.1 Connecting the Computer

Connect the serial cable to the serial (or COM) port in the back of the computer and the COM port in the side panel of the **Thermo Scientific Matrix PlateMate 2x3**.

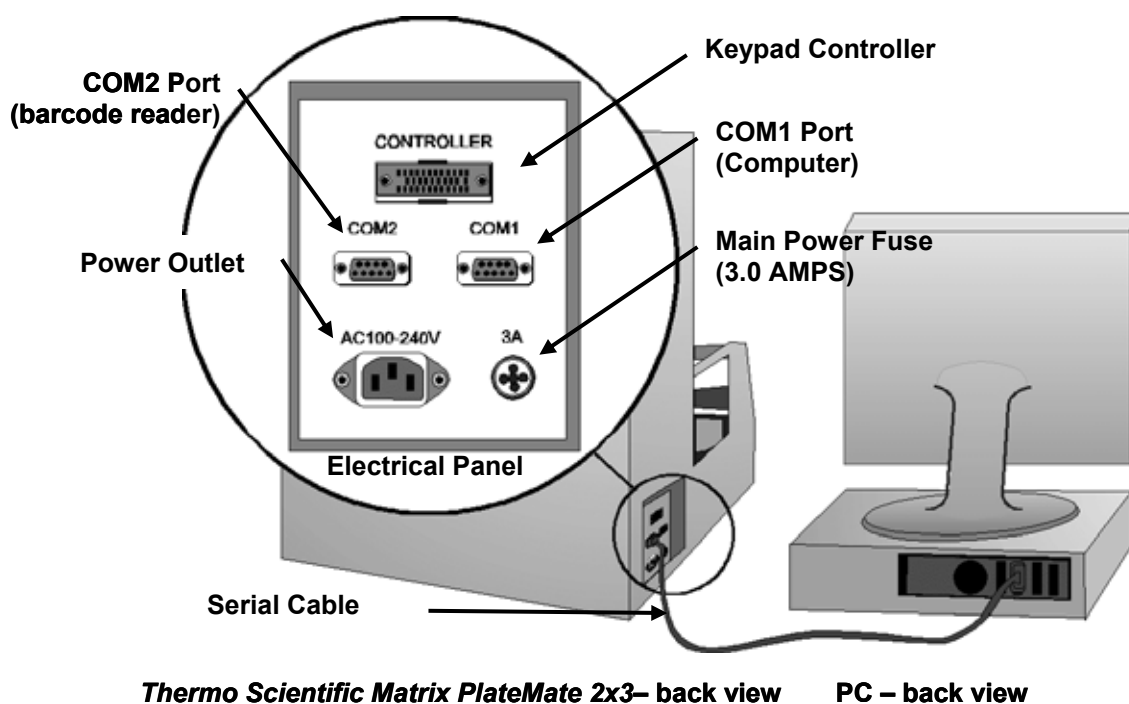


Figure 5: Computer Connection

3.2.2 Installing ControlMate

1. Start Windows and insert the **ControlMate** CD into the CD-ROM drive. The installation program will begin automatically. If your installation program does not launch automatically, use the following steps:
 - a. From the Windows Start menu, click "Run".
 - b. Type "D:\setup" (if the D drive is not correct, change the drive letter to match your CD-ROM drive). If you install **ControlMate** from a server or common directory, enter the complete path name, then "setup".
 - c. Press "Enter" to start installation.
2. Follow the setup instructions on the screen.

3.3 Configuring ControlMate

3.3.1 Starting ControlMate

Start **ControlMate** by clicking “Start” in the Windows Taskbar and selecting **ControlMate** from the Programs menu. The following window appears:



Figure 6: ControlMate Main Screen

When you create a new pipetting sequence, a new window, called child dialog window, opens in the **ControlMate** software.

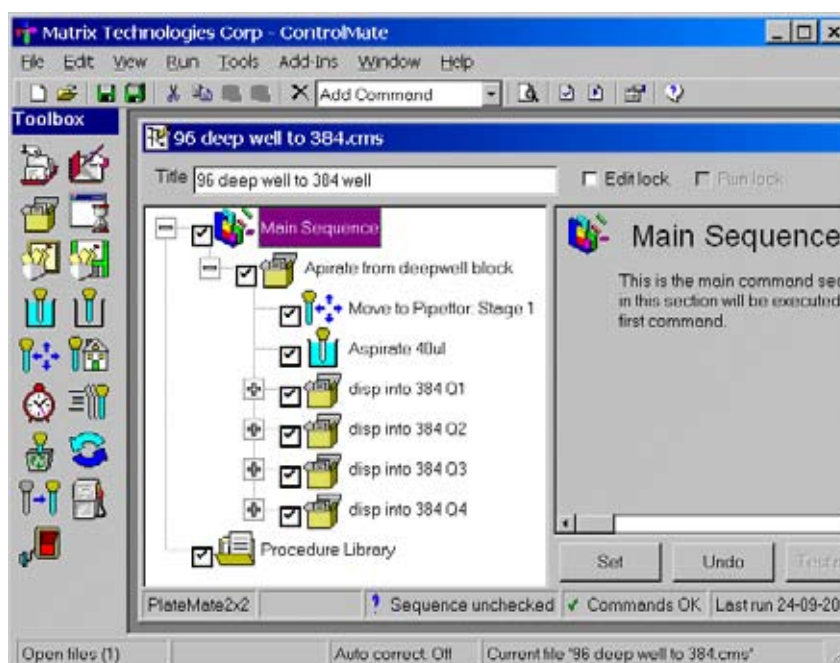


Figure 7: Main Screen with Child Dialog Window

Before you begin creating pipetting programs, you must first configure **ControlMate** to work with your **Thermo Scientific Matrix PlateMate 2x3** system. The next section describes the **ControlMate** configuration settings.

3.3.2 Configuring Device Options

After installing and starting **ControlMate**, configure the software for your **Matrix PlateMate 2x3** system by selecting the “Tools” > “Options” command on the menu bar or by pressing the Options icon  on the main application toolbar.



The Options screen displays tabs for the device configuration screens. The first screen displays computer connection settings.

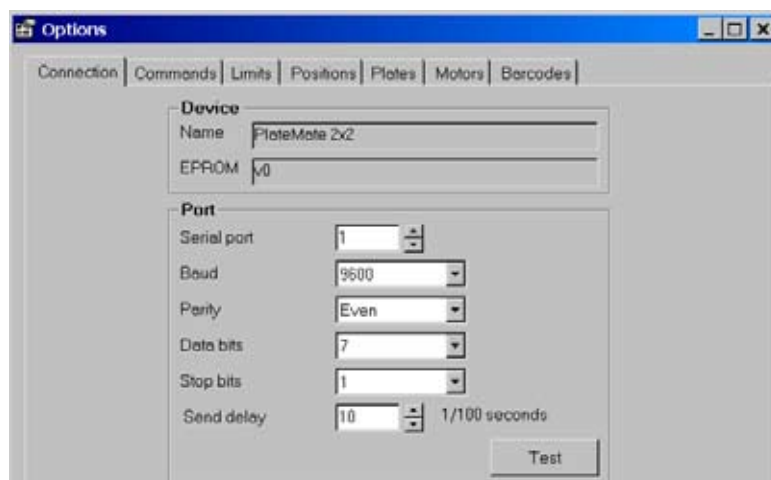


Figure 8: Connection Screen

The configuration screens are described below.

- **Connection:** To set default parameters for serial communication with the device.
- **Command Defaults:** To set the default field values for module-specific commands.
- **Limits:** To set the range limit values for the fields within the module-specific commands.
- **Positions:** To set the location entries for each deck position and to set the device minimum and maximum limits for each axis at each stage position.
- **Plates:** To edit and add information relating to plate and vessel types that are to be used on the device.
- **Motors:** To set device axis home positions.
- **Barcodes:** To set the parameters used for retrieving and storing barcode data.

Connection

The **Thermo Scientific Matrix PlateMate 2x3** device is connected and controlled by a PC via a serial communication port. The parameters that enable communication with the device can be set on this dialogue. It is possible to test the serial connection by clicking the test connection button . This will communicate with the device by issuing a reset command. A warning message will be displayed if the parameters have not been correctly defined, or if the device is not connected and switched on.

Fields

Name

The device name.

EPROM

This field will display the current EPROM version number returned after successfully pressing the 'Test connection' button.

Serial Port

Use this field to set the serial communication port number available on the controlling PC. Range values are from 1 to 256; however, the most common value for most systems is 1.

Baud

Use this field to set the communication speed, this must match the DIP switch setting on the device motherboard. The **Thermo Scientific Matrix PlateMate 2x3** uses a baud rate of 9600.

Parity

Use this field to specify the parity used for serial communication. Default value is "Even"

Data Bits

Default value is 7.

Stop Bits

Default value is 1.

Send Delay

Use this to change the delay between commands issued to the **Thermo Scientific Matrix PlateMate 2x3** device. The lower the value the faster the response to query type commands, for example when querying for tip magazine loading status. However, too low a value may cause the response sent from the device to be lost. If the device is situated in a noisy environment or in a location that is not close to the PC then increasing this value would provide a better means of eliminating noise and interference that may exist on the serial interface cable.

Transaction Log

Checking this box will cause all commands issued via the serial port to be logged into a file (PortLog.txt) which can be found in the application program file directory. To clear the file, click the remove button.

Command Buttons

Test

(Test connection)

Clicking on this button will communicate with the device by issuing a reset command. You must ensure that:

- ☐ The device is connected to the serial communication port on this computer.
- ☐ The fields described above have been correctly set up.
- ☐ The device is switched on.

Clear

(Clear the port log file)

This action will remove all actions from the port log file.

Commands

The command defaults tab sets the default field values for the module specific commands. This means that any values entered against command fields here will be used as initial values when the respective command is added to a sequence file in the Sequence File Editor dialogue.

The screenshot shows a software dialog box titled 'Command' with a dropdown menu set to 'Aspirate'. Below this is a section titled 'Default Values' containing several settings:

- Volumetric:** A dropdown menu showing 'All liquid types @ all temperatures'.
- Overstroke:** An unchecked checkbox followed by 'Volume' and a text box containing '10' with 'ul' as a unit.
- Volume:** A text box containing '5.000' with 'ul' as a unit.
- Dwell time:** A text box containing '0' followed by '1/100 seconds'.
- Tip touch:** An unchecked checkbox followed by 'Action' and a dropdown menu showing 'Side left'.
- Air gap:** An unchecked checkbox followed by 'Volume' and a text box containing '5.000' with 'ul' as a unit.

Fields

Command

This drop down box allows the selection of available module specific commands.

Limits

The fields within the module specific command set have to be validated against a minimum and maximum value for the respective field. This options tab allows the setting of those values. The values are used whenever commands are changed in the Sequence File Editor dialogue or during File Validation.

Only minimum and maximum values can be changed using this dialogue. Some values cannot be changed and are displayed for information purposes only. To change a value, use the mouse pointer to click on the required value and enter the required change. To set the value press the Enter key or click on another field value in the list.

Value	Min	Max	Unit
Aspirate or Dispense volume	0.5	30	ul
Delay after aspirating	0	1000	1/100th second
Delay after dispensing	0	1000	1/100th second
Pause duration	1	100	Seconds
Mix cycles	1	10	Iterations
Wash cycles	1	10	Iterations
Z axis height	0	13000	1/100 mm
Reservoir/wash fill time	0	6000	1/100th second
Blow out volume	0.5	5	ul
Reservoir overfill timeout	0	6000	1/100th second
IO switch momentary duration	1	100	Seconds
Maximum X axis movement	0	15770	1/100th mm

Auto correct invalid values during command edit ☐

Fields

Value

This represents the field type.

Min

This is used to set the minimum value allowed.

Max

This is used to set the maximum value allowed.

Unit

This represents the field unit of measurement, if applicable.

Auto correct values during command edit

When checked, this box enables the auto correction of values which fail command validation in the Sequence File Editor dialogue. The values used will be from the respective setting in the list above. The following rules apply:

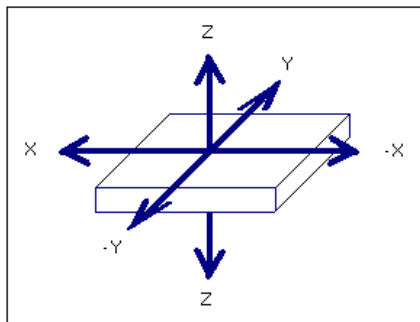
If a field value is below the limit minimum value, then the limit minimum value is used.

If a field value is above the limit maximum limit value, then the limit maximum value is used.

The main application window displays the current status of this field on the status bar at the foot of the window.

Positions

Each position on the device has been mapped to a specific stage location, for example Stage 1 positioned at the pipetting head. Each stage allows for the positioning along 3 axes, which allow for the two (X and Y) associated with the deck positioning and for the tip position (Z axis). These are shown in the following diagram.



The Positions dialogue allows the setting of the minimum and maximum values that a stage can travel on any one of the three axes at any of the defined stage positions. These values are then used within the sequence file editor for each respective command.

Position: Pipettor: Stage 1

Adjust physical location

 Changing any X or Y home values or using the Manual Movement buttons will cause the pipettor head to move.

X home: 100 1/100 mm

Y home: 0 1/100 mm

Move 

Test height

5700 1/100 mm

Manual movement

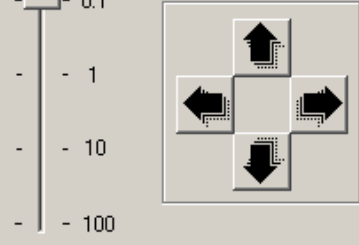
Steps (mm)

- 0.1

- 1

- 10

- 100



Offset limits

X offset: -450 to 450 1/100 mm

Y offset: 0 to 450 1/100 mm

Z offset: 0 to 60000 1/100 mm

Allow column incremental movements ☒

Allow row incremental movements ☐

Reset To Factory Default Settings

Fields

Position

The required stage position.

Adjust physical location: X and Y home

Use these fields to directly enter the respective axis value, in 1/100 mm increments, to set the required position.

Manual movement

The manual movement buttons are used to directly control the deck motors to move the required position. The deck will move in the direction specified by one motor step increment, the value for which is set by the 'Steps (mm)' slider. For example, if the slider is set to 1mm steps and the 'move to the back button' is pressed, then the deck will move 1mm backwards.

Test height

This is the height at which the tips will be positioned after the deck movement. This is useful for when gauging the tip location. If a new position is selected in the 'Position' field then the tips will ignore this height and move to the safe travel height first.

X offset

This allows the amount of movement the selected stage can move from left to right (and right to left) and is represented by two fields, the first being the minimum value, the second being the maximum value. Any value which is negative causes the stage to move to the right (therefore moving the tips to the left of a well for example).

Y offset

This is similar to the *X Offset* fields except that the values represent movement of the selected stage position from back to front (and front to back)..

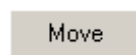
Z offset

These fields, similar to the previous two groups, represent movement of the selected stage position in the vertical axis

Allow column/row incremental movements

These fields are used to define whether the position is capable of allowing incremental movements in the specified direction.

Command Buttons



(Perform movement)

Clicking on this button will communicate with the device to test the associated position.



(Reset from test height)

This will reset the device axes and is used to reset the device after testing (Move the deck to the back)



(Move the deck to the front)



(Move the deck to the left)



(Move the deck to the right)



Selecting this button will reset all field values for the current position configuration to those originally set as the factory default values. Any changes that have been made, via this dialogue, will be overwritten.

Plates

To provide accurate positioning functionality for each stage, the vessel type whether it is a plate, tip wash or even a reagent reservoir must be defined in the plates library. This option is used to set dimensional and positional parameters for each vessel type. The detail and number of entries depends on how accurate the stage positioning is required, either by defining a vessel/plate type for each specific type or by a generic group, for example by defining one vessel type group that represents all 96 well plates that are likely to be used.

It is important to remember that the parameters entered in this dialogue play an important part in the positioning of plates on the device at the tips and at the stackers and whether plate filling is to be enabled by setting the correct values for non plate vessel types such as reagent reservoirs and tip wash units.

To amend information for an existing vessel type, select the respective vessel description in the drop down and then change the required parameters.

Read further on in this topic for information on how to add and copy vessel types

Plate Type
 Description 1536 Square well 'Matrix' (4511B-4517B) Add Delete

Detail for : 1536 Square well 'Matrix' (4511B-4517B)
 Vessel type Plate Height 774 1/100 mm
 Well count 1536 Shape Square Width 170 1/100 mm
 Well spacing 225 1/100 mm ☒ Allow incremental column movements

Depths (1/100mm)
 Well 450 Aspirate 350 Tip touch Z offset 200
 Dispense 250

Well quadrant centres (1/100 mm)
 Applicable to tip magazine that has
☒ 96 tips
☐ 384 tips
☐ 1536 tips

Quadrant	X axis	Y axis
1	338	-338
2	113	-338
3	-113	-338
4	-338	-338

Note:
 Quadrant x/y positions

+x	-x
-y	-y
+x	-x
+y	+y

Fields

Description

The required vessel type for which parameters are to be changed.

Vessel type

The collective name for the vessel, for example a *Plate* or *Reservoir*.

Height

The physical height of the vessel. This is measured from the bottom of the plate to the top of the plate. The height is important as this is used for all movement commands when calculating the height at which the stage can be safely presented to the tips and also for tip touch positioning etc.

Well count

The physical number of wells contained within the vessel. The value can be one of either 96, 384 or 1536. The field is used for determining positional parameters for quadrants etc.

Shape

This represents the physical top shape of the well and can either be *Square* or *Round*.

Width

The well width is especially important for determining well centers and quadrant offsets and tip touching. The field value represents the physical width of the well measured at the top of the well.

Well spacing

The well spacing field is used when determining the distance (in 1/100mm) between well centers and also when incremental column movements are required within a vessel (for example when serial dilution is required). The field value is measured from the center of one well to the next and is also known as the 'well-to-well' spacing.

Allow incremental column movements

This checkbox determines whether the vessel can be used in conjunction with the correct tips for incremental column movements within a vessel, for example when serial dilution is required. If this checkbox is unchecked then the vessel does not support incremental movements regardless of tip usage.

Well Depth

The well depth value is used to define a preset height which defines the bottom of the well. The value entered must be measured from the well top to the well bottom at the well center.

Aspirate Depth

This field is used to represent a pre-set height, available within the Move command. This height is useful for setting a default height at which liquid is aspirated. The larger the value the higher the stage movement (and therefore the further down into the well the tips are positioned).

Dispense Depth

This is similar to the Aspirate Depth with the exception that it is used for determining a pre-set height for dispensing liquids.

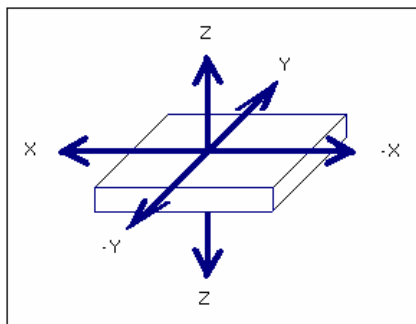
Tip Touch Z offset

Use this field to set a value which will be used when positioning the vessel for tip touch off. The value is used to determine how near to the top of the well the tips are positioned, for example a value of 200 1/100mm will position the vessel so that the tips are approximately 2mm inside the top of the well.

Quadrant Centers

The quadrant grid can be used to enter values which represent the well centers for each quadrant. The X and Y axis offset values are measured from the tip center position when no offsets are applied, for example the dead center for a 96 well plate.

To determine the offset values applied the direction that the stage has to travel is the opposite of the location of the quadrant, i.e. to position tips to the left and back of the plate the stage has to move to the right and towards the front of the device. The Note frame in the dialogue windows and the diagram below show how to apply the offset values.



A different grid with different quadrants is available for each plate, the total number of quadrant groups (i.e. 1, 4 and 16) depends on the total number of wells contained in the vessel and the current selection of the tip radio buttons. The radio buttons are used to redraw the grid based on whether a 96, 384 or 1536 tip set is loaded.

For example, setting the radio button to 96 tips for a 384 well plate would display a grid containing 4 quadrants.

Command Buttons

Add

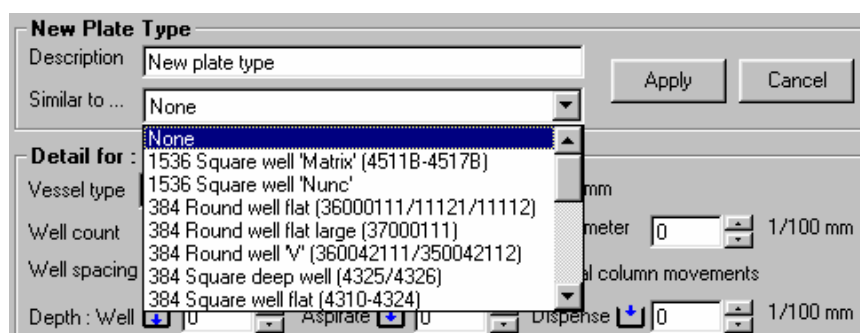
Select this button to add a new vessel type (see further information later in this topic).

Delete

Select this button to remove the currently selected vessel type. A dialogue box will be displayed to confirm or cancel the deletion action.

Adding new vessel types

To add new vessel types, select the *Add* button. This will change the plate type frame to show additional fields to allow the creation of a plate caption and also allow the copying of existing vessel type parameters expediting new vessel creation.



Fields

Description

This allows for the entry of descriptive text that would represent the new vessel type in the selection list.

Similar to...

If the new vessel type is similar to one already defined in the library then use this field. The vessel parameters will be copied and used as a default value for the new type which can then be changed. This is ideal for adding new entries which are similar to, but not the same as, existing entries.

Command Buttons

Apply

Select this button to add the newly defined vessel type to the library.

Cancel

Select this button to cancel the entry of the newly defined vessel type.

Motors

The Motors options dialogue is useful for defining the home positions for each axis motor. The home position is the reference position from which all movements are made. Normally this information is set at the factory and does not require any further changes. Changes made to this dialogue will affect the movement of motors and are not recommended. It is advisable to seek vendor assistance before making any changes.

The screenshot displays a configuration window with four panels. Each panel contains two input fields with up/down arrows. The 'X Axis' panel shows 'Home position' as 0 and 'mm per step' as 0.05. The 'Y Axis' panel shows 'Home position' as 0 and 'mm per step' as 0.05. The 'Z Axis' panel shows 'Home position' as 0 and 'mm per step' as 0.005. The 'Piston' panel shows 'Home position' as 0 and 'Steps per mm' as 250. Each input field is followed by a unit specification: '1/100 mm' for the home position fields and 'mm' for the step-related fields.

Axis	Home position	Unit	mm per step	Unit
X Axis	0	1/100 mm	0.05	mm
Y Axis	0	1/100 mm	0.05	mm
Z Axis	0	1/100 mm	0.005	mm
Piston	0	1/100 mm	250	Steps per mm

(The default settings are shown above)

Fields

Home position

This is used to set the home position, for the respective axis, from which all movements will be made for the axis.

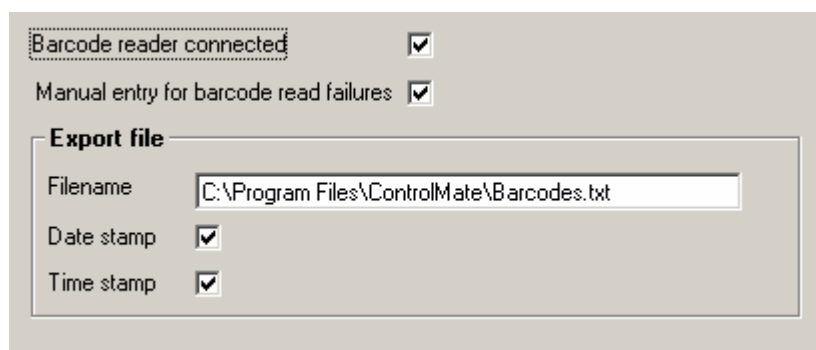
Mm per step/Steps per mm

This is used to define the translation of motor stepper movements to mm for the respective axis.

Barcodes

The Barcodes options dialogue is used to set the parameters associated with the barcode reader attached to the device. All output from a successfully read barcode is written to a file. Each field is comma separated with each record being carriage return and linefeed (CRLF) terminated. The format for each record is :-

Date (DD/MM/YY), time (HH:MM:SS), barcode data (text) CRLF



The screenshot shows a software dialog box titled "Barcodes". It contains several options and an "Export file" section. At the top, there are two checked checkboxes: "Barcode reader connected" and "Manual entry for barcode read failures". Below these is a section titled "Export file" which contains a text field for "Filename" with the value "C:\Program Files\ControlMate\Barcodes.txt", and two checked checkboxes for "Date stamp" and "Time stamp".

Fields

Manual entry for barcode read failures

Check this box to enable the input of barcode text should the barcode reader fail to read a barcode during the execution of a Move command.

Filename

All barcode data that is successfully read will be output to a file. This field will allow the entry of the filename. If this field is left empty then the default filename will be used.

Date stamp

If checked then the current system date will be written along with the barcode data for each successful barcode read.

Time stamp

If checked then the current system time will be written along with the barcode data for each successful barcode read.

3.4 Creating Pipetting Programs

A pipetting program is a sequence of pipetting actions that accomplishes a pipetting task. In the **ControlMate** software, the pipetting program is called a sequence file. Separate sequence files can be created for serial dilutions, plate-to-plate transfers, and simple dispensing operations. Once created and saved, the sequence files can be quickly retrieved for use.

ControlMate software includes a number of sequence file examples, which can help you design your own programs. All commands are supported by online Help. See the remarks in the following section, "Using Online Help". Moreover, every command (menu item) has a Help button for calling context-sensitive Help.

Creation of a sequence file begins with opening a new file window by selecting "New" in the "File" menu, or pressing the key combination CTRL+ N, or clicking the "New Sequence" button . You can view and select the list of program commands by clicking the "Add Command" drop-down menu . Refer to "Help"  for special notes and explanations. After you complete the program, test it for possible errors by clicking the "Validate" button  before executing it with the "Run" button .

NOTE: When testing the program, set the main loop(s) of the program to a low number to keep the testing time short. Once the program has passed the test, the loop counts can be restored to the desired number. Remember to save the program before starting a new program.

Before executing the program on valid samples, perform a dummy run using water to check each step.

3.4.1 Using Online Help

If you need help using the **ControlMate** software program, select the "Help" button  in the Toolbar menu for a list of help topics.

Double click the color-highlighted topics to read the topic descriptions. For faster access to the desired topic, select the "Search" button in the Help menu. Enter the topic to be searched and press the "ENTER" key to begin the search. The help program will display the topics related to the search topic. Select the desired topic and press "Go to" display the help information.

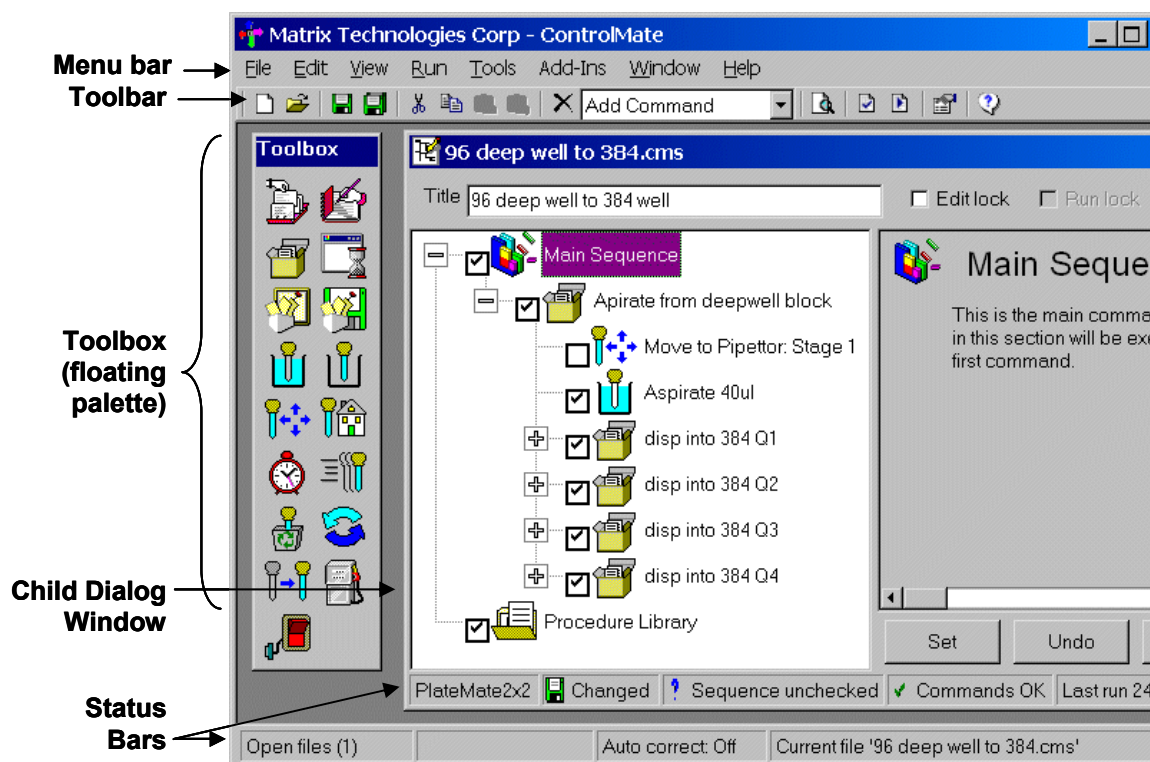
To get help on an open dialog window, click the "Help" button .

To get context sensitive help (getting help on any commands showing in the open window), click on the icon . The mouse pointer changes to match the icon. Position it over the command of interest and press the "CTRL" key together with the right mouse button.

All software commands are available through the window menus. The most commonly used commands are also available through the icons in the icon bar.

3.4.2 Understanding the Main Application Window

The main application window provides function dialogues in the form of child windows. The main operations of the windows are carried out by either selecting an option from the menu bar at the top of the window or by clicking on a toolbar icon.



Menu bar: The Menu Bar shows the major software operations, such as: opening and saving sequence files, editing files, running or validating a pipetting sequence, and changing tips or pipettor head.

Toolbar: The Toolbar provides icons that represent the operations in the Menu bar.

Toolbar Icons

-  Creates New sequence file
-  Opens existing sequence file
-  Shows or Hides toolbox window
-  Saves the current sequence file
-  Saves all open sequence files
-  Cuts the highlighted command onto the clipboard
-  Copies the highlighted command onto the clipboard
-  Pastes the contents of the clipboard below the current command node

Toolbar Icons

-  Views the clipboard contents
-  Deletes the currently highlighted command
-  Adds a new command below the current command node
-  Views print preview
-  Validates the current sequence file
-  Executes the current sequence file
-  Views configuration and default options
-  Views help page

Toolbox: The Toolbox provides easy access to intrinsic or module commands, such as: creating or calling procedures, aspirating or dispensing fluids, moving stage positions, and mixing. The Toolbox is a floating palette and can be positioned anywhere on the screen. The commands in the Toolbox can also be selected from the “Add Command” drop-down menu in the Menu bar.

Toolbox icons

Intrinsic Commands



Call Procedure: Calls a procedure from within the current sequence file or from another sequence file. Saves time by reusing an existing procedure.



Notepad: Creates a note in the sequence file. Useful for documenting the steps in the sequence and for reminders during the pipetting procedure.



Group Commands: Groups together commands for a common purpose. For example, the commands used to perform a common mix procedure can be grouped together.



Procedure: Executes a series of commands whenever the procedure is called from the main sequence. For example, a simple pipetting procedure would consist of a move to position, aspirate, second move to position, and dispense commands

Global : Define the name and format of a register, called a Global Value, that is designed to hold a value. A global value command can be added anywhere to the sequence file tree structure.

Assign: Change or define field or other Global Value command values. The field value change can be made either before a command executes, for example to change the current quadrant, or after a command executes, for example to capture a plate barcode.

Export: Extract information held in global values into external text based files



Aspirate: Aspirates a measured volume. Should be preceded by a move command.

Toolbox icons

Module Commands		Dispense: Dispenses a measured volume or all of the liquid in the tips. Should be preceded by a move command.
		Move to Position: Position a stage to a specific location on the instrument. For example, a stage must be moved under the pipet tips prior to the Aspirate or Dispense command.
		Home Axes: Resets a piston or stage to its home position.
		Pause: Inserts a pause into a program to stop processing according to the pause parameters. Once the continue condition has been reached, the program continues to the next step within the sequence.
		Speed Control: Adjusts piston speed (aspiration or dispensing speed), horizontal and vertical stage speeds.
		Wash Tips: Washes inside and outside of pipet tips. Requires automated wash reservoir.
		Mix: Aspirates and dispenses a measured volume in specified cycles to mix the microwell content. Also equalizes vapor pressure within the pipet tips to ensure accurate volume delivery. Should be preceded by a move command.
		Change Tip Magazine: Pauses sequence file execution for tip magazine change. Provides step-by-step instructions to change tip magazine.
		Reservoir Pump: Specifies upper or lower reservoir pump, left or right liquid level sensor, speed, direction, duration, and overflow timeout.
		I/O Switch: Controls on and off switch for one and two I/O (input/output) connections.

Child Dialog Windows: The Child Dialog Window opens whenever you click a **ControlMate** function or open a sequence file.

Status Bars: The Status Bars provide information relating to the save status, open file, and auto correction.

3.4.3 Creating Sequence Files

Sequence File Editor

The sequence file editor dialogue window is used to create or amend sequence file programs.

The dialogue contains a number of frames:

File Header

The file header contains the field's specific to the whole sequence file.

Command Tree

The command tree represents the program sequence. Sequence files are executed from the top to the bottom of this tree structure. The tree structure is used to add, delete and select commands.

Command Settings

The command settings frame is used to change specific command field values.

Status Bar

The status bar provides information relating to the sequence file that is currently open.

File Header

The file header contains the fields that are specific to the whole sequence file.



Fields

Title

A text entry used to label the file for captions and reports.

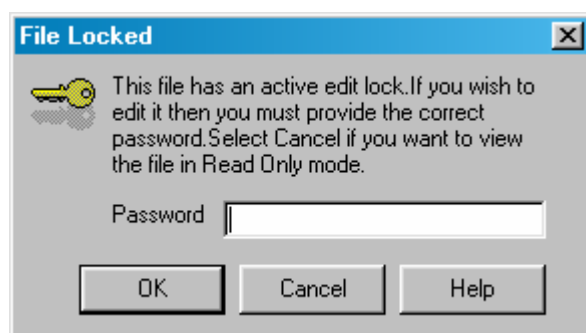
Edit Lock

Used to set a password on the file to control access for editing. Checking this field will display the Edit Lock dialogue window.

Run Lock

Used to set a password on the file to control access for execution. Checking this field will display the Run Lock dialogue window.

Edit and Run Locks



The edit and run lock dialogues are used to control access to sequence file editing and execution on a file level basis. Once a lock has been set, the correct password is required to enable access to all file functions. This means that it is possible to create sequence files and then set an edit lock to prevent a file from being changed. This is useful for example, in creating file templates where the new files are created based on existing ones.

When setting a run lock the lock dialogue will prompt for a password and then prompt for confirmation of the password. If the two password entries do not match then the lock is not set.

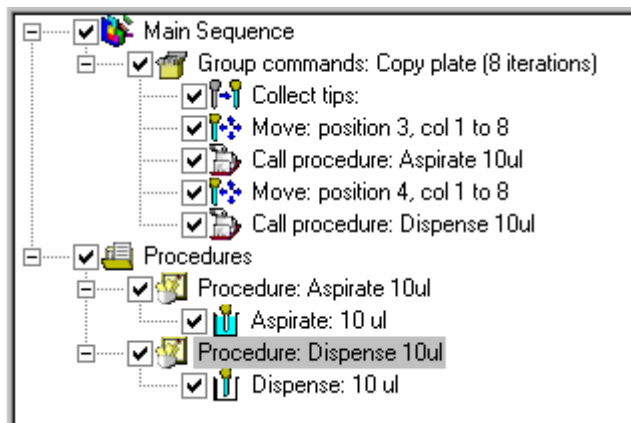
Note: Passwords are case sensitive.

Password Validation

Sequence files that have an edit or run lock set will cause this dialogue box to be displayed whenever the file is opened within the sequence file editor (if edit lock set) or file execution (if run lock set). The dialogue will prompt for a password. If an incorrect password is entered, file access via the lock is not granted. This means that in the case of an edit lock, the file cannot be edited or in the case of a run lock, cannot be executed on the device.

Command Tree

The command tree represents the program sequence. Sequence files are executed from the top to the bottom of this tree structure. Commands can be manipulated in the tree structure in a number of different ways.



- Adding a new command**
 Commands are added to the tree (or command) structure by either clicking the required command icon on the Command Toolbox dialogue or by selecting the required command from the drop down menu on the main application toolbar. Commands are added directly underneath the highlighted command.
- Deleting an existing command**
 Existing commands can be deleted from the command structure by highlighting the required command and then either pressing the “Delete” key on the keyboard or by clicking on the delete icon  on the main application toolbar.
- Moving a command**
 Commands can be moved to a new position in the sequence structure using the “drag and drop” method. To move a command, highlight it, then while keeping the left mouse button pressed, drag it to the new position and then release the mouse button. Commands are moved below the one indicated as the new position. An alternative to dragging commands to new positions would be to use the Cut, Copy and Paste buttons, which uses the clipboard to move or copy commands.
- Execution selection of commands**
 Commands can be selectively included or excluded from execution. To prevent a command from executing, check the box beside the icon of the required command in the tree structure. Checking (or unchecking) a group command will cause the child commands of that command to be checked (or unchecked).

Cut, Copy and Paste

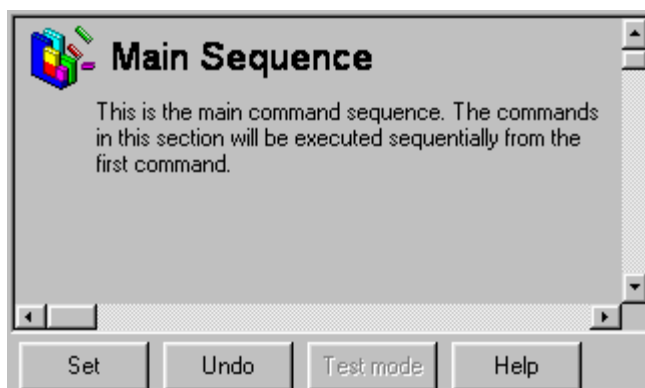
Commands in the command tree can be cut, copied to or pasted from the clipboard. This is useful when creating or editing sequence files and speeds up the process of reusing commands rather than deleting them and recreating them manually.

If the current command is a group command such as main sequence, command group or procedure, then all child commands will follow the same action as their parent.

-  **Cut**
To cut a command, highlight it and then click this button on the toolbar.
-  **Copy**
To copy a command to the clipboard, highlight it and then click this button on the toolbar.
-  **Paste**
To paste a command from the clipboard, highlight the command after which the new command is to be pasted, then click this button on the toolbar.

Command Settings

The command settings frame is used to change specific command field values.



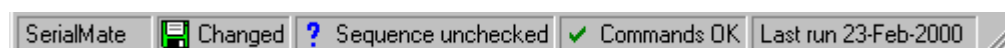
Command Buttons

- **Set**
This refreshes the screen and updates the tree structure with the changes made. The changes are not saved to file until a save file option has been selected. Values are checked for validation against the rules (which can be set via the Tools – Options dialogue) before they are written to the tree structure. Any validation errors are displayed in a frame below the command setting frame and the icon in the tree structure is displayed overlaid with a red cross to indicate invalidity.
- **Undo**
This will change the settings back to the original values prior to the current edit.

- **Test mode**
This allows the values for the command to be tested on the device by restricting the editor to the current command only. Any changes made are then sent directly to the device. This is useful, for example, for the testing of heights and positions. To return from this mode select the button again (it will now show *Edit Mode* as a caption).
- **Help**
Displays help for the respective command.

Status Bar

The status bar provides information relating to the sequence file currently open.



New Screen shot

Panels

- **Module**
This panel displays the respective device module name to which the commands relate.
- **Changed Status**
This shows the current edit status of the file and displays whether or not any changes have been made.
- **Sequence Validation**
This panel indicates whether the entire sequence has been checked for validation and whether the validation has passed or failed. The sequence validation looks at the command relationships rather than the individual limit values of commands. This is useful for determining total volume levels, etc. throughout the sequence. Sequence validation is carried out via either File Validation or File Execution.
- **Command Validation**
This provides status on the validation of individual commands, for example, an incorrect height value may have been entered.
- **Last Run Information**
The duration and date of the last run (if applicable) for the respective file is displayed in this panel. Determining run time is useful for workload planning.

Toolbox

The command toolbox contains all of the intrinsic and module specific commands that can be used to create sequence files for the current device installation.

To add a command from this toolbox, highlight the command in the command tree after which the new command is to be added and then click on the icon of the command required. If the command is added at the incorrect position, it can be moved to the required location within the command tree.

The command toolbox can be dragged and positioned anywhere within the **ControlMate** window environment. It can also be 'docked' by positioning it against the side of the application window (left, right, top or bottom). If the toolbox is not docked then it will 'float' over the top of other window dialogues to ensure that the command icons are always visible.

The size of the command icons can be set to either *small* (default) or *large*. Use the View menu to do this. From this menu, it is also possible to choose to display text captions associated with each command icon, using the *Toolbox Text* option.

Clipboard Viewer

The clipboard viewer displays the current contents of the command clipboard. This is useful when using the Cut, Copy and Paste features of the command tree within the sequence file editor window.

Module Specific Commands

The module specific commands for the **Thermo Scientific Matrix PlateMate 2x3** device relate to the control of the pipetting head and the liquid handling parameters.

The following commands are available:

- ☐ Aspirate
- ☐ Dispense
- ☐ Move
- ☐ Mix
- ☐ Home
- ☐ Pause
- ☐ Wash Tips
- ☐ Change Tip Magazine
- ☐ Speed Control
- ☐ Reservoir Pump Control
- ☐ I/O Switch

The following Add-In modules are also available:

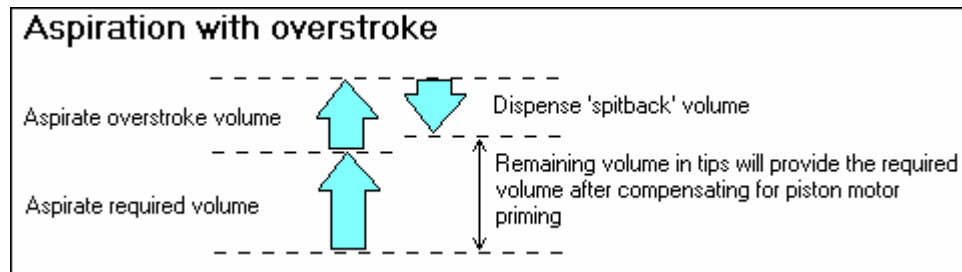
- ☐ Change Pipettor or Tips
- ☐ Volumetric Calibration
- ☐ Calibrate Device

Aspirate Command

Aspirates a specified volume. The command will cause the piston motor to aspirate the given volume. The aspiration is immediate and therefore requires the use of a preceding Move command to ensure that a vessel is correctly positioned at the tips. Checks exist to ensure that the piston does not over aspirate and therefore stays within the maximum volume limit defined for the current piston head.

An option exists within the command to factorize the volume required based on volumetric calculation settings for different liquid types at different temperatures.

Aspirating with overstroke on the first volume ensures that the piston motor is primed, this is especially useful at lower volumes and works to ensure consistency and accuracy throughout a series of incremental dispense. Aspirating with overstroke is required when smaller aliquots are to be dispensed after a large volume aspiration.



If dry tips are used, more time is required to saturate the dry air with moisture, while vapor pressure increases above the liquid, inside the tips. As a result, dry tips may cause liquid to be driven out. This can affect accuracy. To avoid this, use the Mix command prior to a programmed aspiration to equalize the air in the tips before pipetting the liquid. Proper vapor pressure will be maintained even if the device is left idle with filled tips for a prolonged period.

 **Aspirate**

Volumetric:

Overstroke: ☐ Volume: ul

Volume: ul

Dwell time: 1/100 seconds

Tip touch: ☐ Action:

Air gap: ☐ Volume: ul

Fields

Volumetric

If greater volumetric accuracy is required then select an entry from this drop down list which best represents the liquid sample type and temperature range. This will factorize the volume used by increasing or decreasing the motor steps accordingly. If no volumetric correction is required then use the default setting.

Overstroke

Check this box if the aspirate is the first aspirate prior to multiple dispenses. This will ensure that the piston motor is primed and improves volumetric accuracy throughout all subsequent dispense aliquots.

Volume

The liquid volume to be aspirated. The increment and decrement buttons will change the volume value accordingly. The increment for these actions can be set via the Change Pipettor or Tips Add-In

Dwell Time

The dwell time is used to specify a period of time over which to leave the tips in the sample immediately after the aspirate step for equalizing air pressure and liquid movement inside the pipette tips.

Tip touch

This action causes the tips to be touched against the top of the well after aspiration to remove liquid, which may have adhered to the side or bottom of the tips.

Note: Tip touch is executed near to the chosen vessels well top, the height of which can be adjusted via the Tip Touch Z offset value in Tools – Options – Plates.

Post air gap

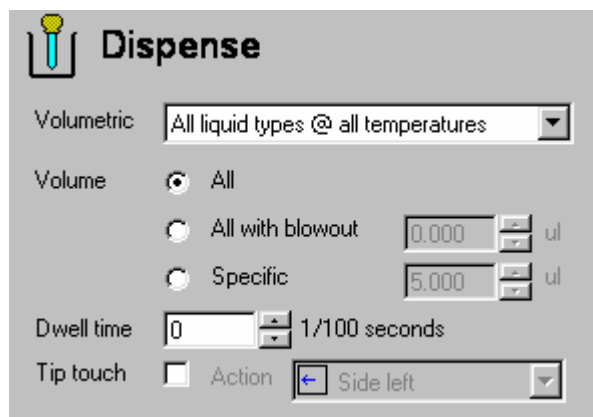
This introduces an air gap at the end of the tip to ensure that sample does not leak during stage movement.

Dispense Command

Dispenses a measured volume or all of the liquid in the tips. The command will cause the piston motor to dispense the given volume. The action is immediate and therefore requires the use of a preceding Move command to ensure that a vessel is positioned at the tips.

An option exists within the command to factorize the volume required based on volumetric calculation settings for different liquid types at different temperatures.

Dispensing with blow out on the last dispense of a cycle ensures that the piston is reset to the home position.



Fields

All

If checked this will dispense all liquid in the tips. This does not perform a piston reset at the end of the action. This is important to remember, use All with blowout if a piston reset is required.

All with blowout

This will dispense all volume in the tips plus an additional air blowout. The blowout volume can be defined in the adjacent volume field. After the blow out has completed the stage moves to position the tips at the top of the well (out of liquid) where the piston will return to its home position.

Specific

Selecting this option will dispense the specified volume in the adjacent field.

Note: Choose this option when dispensing small aliquots after an aspiration with overstroke.

The increment and decrement buttons will change the volume value accordingly. The increment for these actions can be set via Change Pipettor or Tips Add-In

Dwell Time

The dwell time is used to specify a period of time over which to leave the tips in the sample immediately after the dispense step for equalizing air pressure and liquid movement inside the pipette tips.

Tip touch

This action causes the tips to be touched against the top of the well after dispensing to remove liquid, which may have adhered to the side or bottom of the tips.

Note: Tip touch is executed near to the chosen vessels well top, the height of which can be adjusted via the Tip Touch Z offset value in Tools – Options – Plates.

Move Command

This command is used to position the deck to any of the positions defined in the Position Library created via the Positions tab of the Tools Options menu option.

The vessel positions, stages, on the deck are numbered from 1 (back left), 2 (back right), 3 (center left), 4 (center right), 5 (front left), and 6 (front right). The movements are grouped into six position types by default, however it is possible to defined any position within the position library editor :-

- ☐ Position a vessel under the pipetting head
- ☐ Position a vessel for plate placement or removal
- ☐ Position a vessel for barcode reading
- ☐ Position a vessel under the dispensing location for the use of the Reservoir Pump Control command

The move command is a very important command in the collection of commands since all actions require the positioning of a stage somewhere on the device. It is therefore possible to test the actions of a move command when editing a

sequence file by selecting **Test mode** within the Sequence File Editor dialogue window.

- ☐ Movements to position for pipetting
- ☐ Movements for vessel placement

Movements to position for pipetting

Move to Position

Position: Pipettor: Stage 1

Vessel type: 384 Square well flat (4310-4324)

Height: ☒ Preset: Well top ☐ Specific: 9460 1/100 mm

Quadrant: 1

Tip/well offset: ☐ ☒ Predefine: Side top left ☐ Specific: X: 0 1/100 mm Y: 0 1/100 mm

Column: ☐ Start: 1 End: 1 Increment: 1

Row: ☐ Start: 1 End: 1 Increment: 1

Read barcode: ☐

Fields

Position

Sets the stage position. Other field parameter availability is dependent on the position selected, for example selecting a 'Plate/Remove vessel' position will only show fields applicable for vessel placement.

Vessel type

Specifies the vessel type which is situated at the target location. Different vessel types have different settings for the other fields within this command. The values for this drop down list are created via the Options: Plates window dialogue.

Height

This specifies the height at which the tips should be lowered. Heights can either be set by choosing one of the preset heights, as determined by the vessel type parameters or by setting a specific height value. Movement is measured from the position when the tips are at their home location to at the base of the stage downwards.

Quadrant

If the combination of vessel well count and tip count allows for movement to different 'quadrants' within a vessel then this field will be made available. Quadrant offset values are entered via the Options: Plates window dialogue for the respective vessel.

Tip/well offset

It may be necessary to position the tips away from the center of each well, for example when using 384 well plates with low volumes it may provide more accuracy by positioning the tips in one of the well corners. Checking this field will allow the setting of tip positioning by one of the pre set positions or by specifically entering X and Y axis offset values. See Options: Positions and Options: Plates window dialogues for more information on entering offset values.

Column

If the vessel type specified and the currently load tip magazine allows for incremental column movements within a plate then this field will be made available. An example would be in the process of serial dilution in rows across a plate. Once checked the column start, end and increment fields will be made available.

Start column

Specifies the first column on the vessel to be positioned under the tips.

End column

Specifies the last column on the vessel from to be positioned under the tips. If this value is set to one that is greater than the start column and the command exists in a command group which has a loop counter greater than 1 then the device will process the columns by incrementally increasing the column number in each loop pass.

Row

If the vessel type specified and the currently load tip magazine allows for incremental row movements within a plate then this field will be made available. An example would be in the process of serial dilution in columns down a plate. Once checked the row start, end and increment fields will be made available.

Start row

Specifies the first row on the vessel to be positioned under the tips.

End row

Specifies the last row on the vessel from to be positioned under the tips. If this value is set to one that is greater than the start row and the command exists in a command group which has a loop counter greater than 1 then the device will process the rows by incrementally increasing the row number in each loop pass.

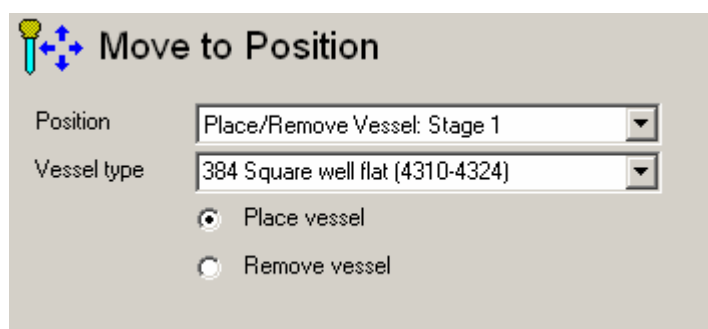
Increment

This is used to set the row increment value. A value of 1 will cause the stage to move to each well of the selected vessel.

Read barcode

If the vessel type is one of PLATE and the preset height is Barcode Height then this field will be made available. During execution a dialogue box may be displayed if the barcode reader fails to read a barcode. Use Tools – Options – Barcodes to set whether or not to display the manual barcode entry dialogue window.

Movements for vessel placement



Note: Selecting a position which is based around vessel placement will show a different set of fields specifically related to the control of plate placement or removal.

Fields

Position

Sets the stage position. Other field parameter availability is dependent on the position selected, for example Selecting a pipettor position will only show fields applicable for pipetting.

Vessel type

Specifies the vessel type which is situated at the target location. Different vessel types have different settings for the other fields within this command. The values for this drop down list are created via the Options: Plates window dialogue.

Place vessel

During file execution the deck will be positioned at the location specified by the position field. The user will then be prompted to place a vessel, the type of which as specified in the vessel type field. The user will then be required to select the 'OK' button to continue.

Remove vessel

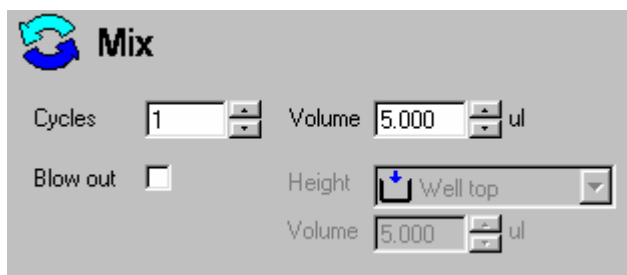
During file execution the deck will be positioned at the location specified by the position field. The user will then be prompted to remove the vessel, the type of which as specified in the vessel type field. The user will then be required to select the 'OK' button to continue.

Mix Command

If dry tips are used, more time is required to saturate the dry air with moisture, while vapor pressure increases above the liquid, inside the tips. As a result, dry tips may cause liquid to be driven out. This can affect accuracy. To avoid this, use the mix option prior to a programmed aspiration to equalize the air in the tips before pipetting the liquid. Proper vapor pressure will be maintained even if the device is left idle with filled tips for a prolonged period.

The Mix command should also be used to aspirate/dispense liquid in a vessel to re-suspend material in the vessel so that a homogenous solution can be created prior to aspiration.

This command requires a preceding Move command to ensure that the vessel is positioned at the tips.



Fields

Cycles

This field is used for defining the number of mix cycles required.

Volume

The liquid volume to be aspirated and dispensed during each mix cycle. The increment and decrement buttons will change the volume value accordingly. The increment for these actions can be set via the Change Pipettor or Tips Add-In

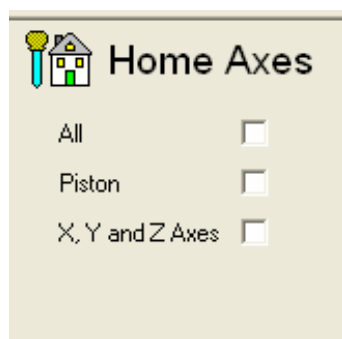
Blowout

This field will, if checked, ensure that a blowout is performed after the last mix cycle. The height at which the blowout is to be performed and also the volume to blowout can be set.

Home Axes Command

Occasionally it may be necessary to reset an axis to its home position during file execution.

It is possible to reset individual axes or by selecting one option to reset all axes.



Fields

All

If checked will reset all axes including the piston.

Caution: This will cause any liquid in the tips at the time to be dispensed over stage position 2. It is therefore advisable to position a vessel (such as a wash station or reservoir) under the tips before executing this command.

Piston

Resets the piston motor.

X, Y and Z Axes

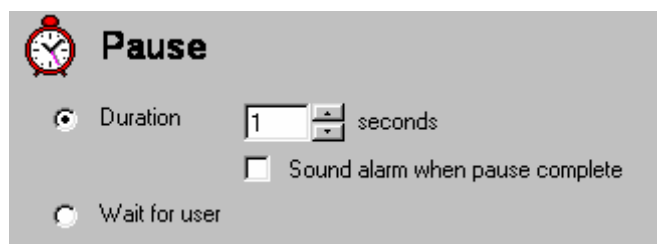
Checking this field will reset the X, Y and Z axis respectively for each stage position.

Pause Command

Inserting a pause command into a program causes the device to stop processing according to the pause parameters. Once the continue condition has been reached, the program continues at the next step within the sequence.

There are two types of pauses. These are:

- ☐ Time based.
- ☐ Infinite - requiring a user to specify when to resume.



Fields

Duration

This causes the device to pause for a set timed interval.

Seconds (duration)

This specifies the time interval over which to pause if the Duration checkbox has been checked.

Sound alarm when pause complete

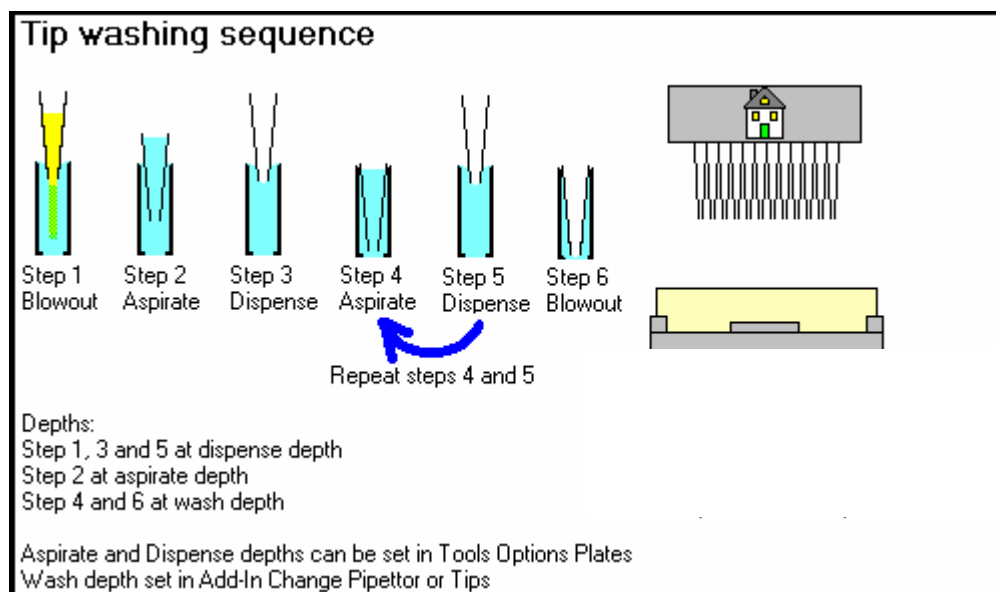
This will sound the internal speaker on the PC 5 times once the pause period has been reached.

Wait for user

This pauses the device indefinitely and requires the user to select when to continue via a window dialogue.

Wash Tips Command

The wash tips command facilitates the washing of both the inside and outside of each tip loaded in the tip magazine. The command uses the wash reservoir which can be positioned at any stage position that allows access to the wash liquid and waste pump connectors.



The command may require a preceding Move and Reservoir Pump Control command to optionally pre fill the reservoir and also to position the wash station at the tips.



Fields

Cycles

This field is used for defining the number of wash cycles required.

Pump speed

The wash pump speed can be controlled by using this field.

Volume

The liquid volume to be aspirated and dispensed during each wash cycle. The increment and decrement buttons will change the volume value accordingly. The increment for these actions can be set via the Change Pipettor or Tips Add-In

Dispense: Into chimneys

This field will, if checked, cause the dispensing within the tip wash vessel chimneys.

Dispense: Into waste bath

This field will, if checked, cause each dispense in the wash cycle to occur in between wash station chimneys and directly into the waste bath. The tips will be positioned diagonally behind and to the right of the chimneys prior to each dispense step in a wash cycle.

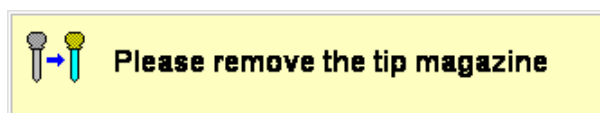
Note: This wash step must be preceded by a **Move** command for Vessel Type: *Tip wash 96 well into waste bath* or *Tip wash 384 well into waste bath*.

Blowout

This field will, if checked, ensure that a blowout is performed after the last wash cycle.

Change Tip Magazine Command

This command is used to pause a sequence file execution in order for the tip magazine to be replaced. The command has the ability to check and issue the instruction to pause and replace tips each time it is called within a program sequence or by an incremental counter to check the usage. To use the incremental counter, the command must exist in a command Group that uses iterations.



Changing the tip magazine will either display a series of window dialogue prompts on the screen (see above) or simply wait for the magazine change sequence to complete. Either way, the routine is based on the tip magazine sensor (limit switch) status at different steps within the change sequence to indicate when a step has completed.



Fields

Track usage

This sets an internal counter that determines when tips should be changed within a loop.

Change after (n) uses

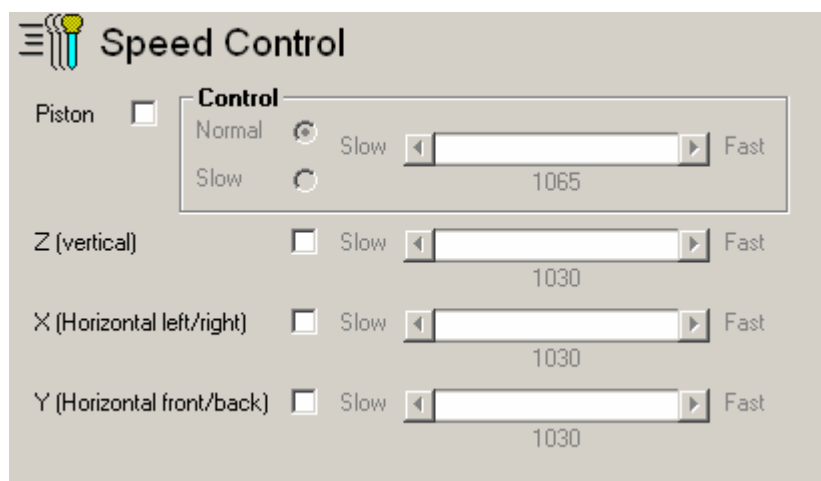
This determines the internal tip change counter. This field is only displayed if the Track usage check box has been checked.

Manual/Automatic

The setting of these radio buttons determines whether the window dialogue prompts are shown above or not. Either way the process waits for changes in the magazine tip sensor status to determine the current step before continuing.

Speed Control

Piston, horizontal and vertical speeds can be adjusted using the Speed Control command.



To change a motor speed, click the check box for respective motor and then use the slider to set the required speed. The number under the slider indicates the current numerical value of the speed setting. **The lower the number the faster the motor action.**

Reducing piston speed is recommended for improving accuracy and precision for high viscosity liquids. Further to this it is also possible to select which scale of piston speed movement to apply. Selecting to use a slow piston speed is useful when dispensing small volumes.

A speed setting used in a sequence file is used for that motor until another speed control command is encountered in the sequence during file execution. The default speeds for all motor axes are set at their respective maximum settings. Speed commands must appear before a Move, Aspirate or Dispense commands in order to use this feature.

Reservoir Pump Control

The reservoir pumps can be used to fill reservoir vessels and can also provide finite control over the speed at which the liquid flows in either direction (fill or empty). Typically there are two pumps and their respective outlets available; these are positioned on either side of the pipetting head. The pumps can be controlled by either filling until a reservoir liquid level sensor is activated or by filling or emptying for a fixed length of time. Using a sensor rather than a fixed duration to control pump motor activation will reduce the operating time of a process if the reservoir is to be used many times during a run.

Note: A "Move" command must be added to the sequence prior to a Reservoir Pump Control command to ensure that a reservoir vessel is positioned at the dispensing location. The "Move" command must have a "Reservoir" position specified. The software will prevent the file from executing if this is omitted.

Reservoir Pump Control

Pump

☒ Upper

☐ Lower

Control

Speed Slow Fast

Direction ☒ Fill

☒ Until full Overfill timeout 1/100 seconds

☒ Left sensor

☐ Right sensor

☐ Duration 1/100 seconds

☐ Empty Duration 1/100 seconds

Fields

Pump – Upper/Lower

Selects the outlet and associated pump to use

Speed

Specifies the pump speed. The faster the speed the less time taken to fill a reservoir. Slower speeds will give more volume control

Direction – Fill/Empty

Specifies the pump motor direction used to either fill a reservoir vessel or to empty residual liquid in the tube connected to the pump

Until Full

Select this option if the vessel is to be filled until the liquid level sensor is activated. This is useful for filling empty vessels and can reduce operating time when reusing vessels that already contain liquid.

Overfill timeout

Checking this field will guard against overfilling a vessel by switching off the respective pump if the associated sensor does not detect the liquid within the time specified. These fields are only available if “until full” is selected.

Left sensor/Right sensor

This field is used for defining which sensor to check when filling ‘Until full’.

Duration (Fill/Empty)

This setting is provided to allow reservoir vessels to be filled or for tubes connected to pumps to be emptied by operating the associated pump for a fixed duration.

I/O Switch

One connector exists in the center of the deck by which an additional externally operated device can be attached. This command will control the activation of the DC supply to the connector. This supply can be switched on or off and also constant or momentarily.



The screenshot shows a software window titled "I/O Switch" with a red and yellow icon. It contains two main sections: "Connection" and "Action".

Connection

- ☒ Left
- ☐ Right

Action

- ☒ On
 - ☒ Constant
 - ☐ Momentary seconds
- ☐ Off

Fields

Connection One/Connection Two

Selects the outlet to use, when using the **Thermo Scientific Matrix PlateMate 2x3**, use Connection One only. Connection Two is available for Matrix PlateMate 2x2 only.

Action On/Off

Specified whether to switch on the DC supply or to switch off the DC supply. Switching Off would normally be selected after a previous command which had switched on the supply for constant use.

Constant

Selecting this option will cause the DC supply to be switched on constantly. Another I/O Switch command will be required later in the file sequence to switch off the supply.

Momentary

Selecting this option will cause the DC supply to be switched for the duration specified in the 'seconds' field and then switched off again.

Sequence rules

There are a few simple steps to follow when creating sequence files for the **Thermo Scientific Matrix PlateMate 2x3** device. To achieve successful liquid transfer the following rules must be observed:

- A Move command must precede (not necessarily directly) each Aspirate, Dispense, Mix and Wash Tips commands.
- If dispensing specific volumes then the total volume dispensed cannot exceed the total volume aspirated except for when dispensing all with blow out.
- The start column and end column fields in the Move command can be used to set the pipetting head position at different columns within a plate. This requires the installation of a tip magazine that has single tip columns. This facilitates tasks such as serial dilution or an incremental dispense to multiple columns. If this incremental row movement is required then remember to place the Move command (or a call to a Procedure containing a Move command) within a Command Group that has a loop value greater than 1.
- Typically aspiration must precede a dispense action

The rules above are checked whenever the File Validation or File Execution options are selected.

Add-In Commands

Change Pipettor or Tips

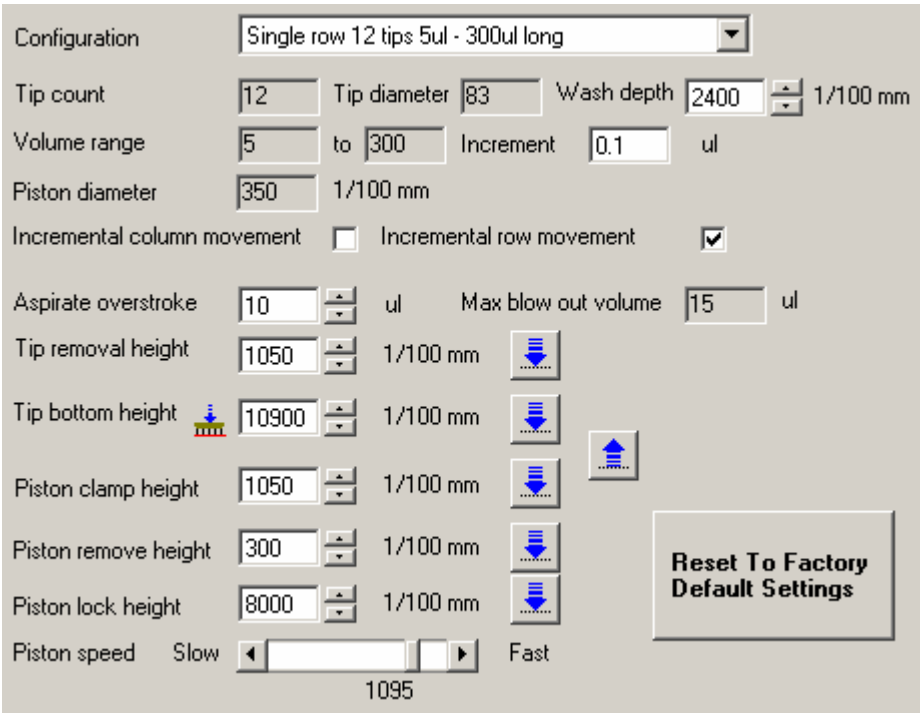
This option assists in the installation of a new piston head and tip magazine or tip magazine only. Tip magazines can also be changed by including the Change Tip Magazine as part of a sequence file program.

- ☐ Change pipettor and tips
- ☐ Replace pipettor or tips

Change Pipettor and Tips

Use this dialogue to load new or edit existing pipettor and tip parameters. The information set up here will be used in any sequence file command so it is important that the information is accurate. The information loaded must correctly reflect the physical characteristics of the pipettor head and tips currently loaded.

Height settings within this dialogue can be tested by selecting . The stage can be reset by selecting .



Configuration: Single row 12 tips 5ul - 300ul long

Tip count: 12 Tip diameter: 83 Wash depth: 2400 1/100 mm

Volume range: 5 to 300 Increment: 0.1 ul

Piston diameter: 350 1/100 mm

Incremental column movement: ☐ Incremental row movement: ☒

Aspirate overstroke: 10 ul Max blow out volume: 15 ul

Tip removal height: 1050 1/100 mm 

Tip bottom height:  10900 1/100 mm 

Piston clamp height: 1050 1/100 mm 

Piston remove height: 300 1/100 mm 

Piston lock height: 8000 1/100 mm 

Piston speed: Slow  Fast

1095

Reset To Factory Default Settings

Fields

Configuration

Selects the actual tip and pipettor head configuration required.

Tip count

Physical number of tips in the tip magazine.

Tip diameter

Physical measured tip diameter. This is useful since it is used in positioning movement such as tip touch and well offsets.

Wash depth

This value represents a physical measurement as to how far the respective tips can be pushed into the wash station chimneys during the tip wash cycle.

Volume range

Identifies the minimum and maximum values used for checking the piston movement for volume limits.

Increment

This field is used for determining the increment value associated with the volume increment and decrement buttons in a number of sequence commands.

Incremental column movement

If the selected tip magazine allows for incremental column movement across a plate (for example when performing serial dilution) then this field, when checked, will enable the correct fields within the Move command.

Aspirate overstroke

This identifies the amount of overstroke that is applied if the option is selected in the Aspirate command.

Tip removal height

This height is used to determine the amount of travel the piston has to move in order to release the tip magazine.  can be used to test this field value.

Tip bottom height

This field value is used to determine the reference point from which all height movements are calculated when positioning stages at the pipettor head. The value is measured from top surface of a stage at the home position (at the lowest point) to the end of the tips (when the magazine is loaded). Getting this value wrong will cause all height movements to be inaccurate.

Piston clamp height

This field value is used to set the travel distance the piston has to move in order to expose the 4 piston clamps. This is used when the *Change Pipettor and Tips* radio button has been selected.

Piston remove height

Used to set the distance the piston motor has to move in order to release the piston head.

Piston lock height

Used to set the height at which the head is lowered to reveal the piston head lock clamp knobs situated on either side of the head unit.

Piston speed

This slider sets the value by which the piston motor moves during head and tip replacement.

Command Buttons



(Test height)

Clicking on this button will communicate with the device to test the associated height.



(Reset from test height)

This will reset the device axes and is used to reset the device after testing heights. All axes will return to their home positions.



Selecting this button will reset all field values for the current piston/tip configuration to those originally set as the factory default values. Any changes that have been made, via this dialogue, will be overwritten.

Replace Pipettor or Tips

This dialogue is used to physically control the device to either replace the piston head and tip magazine or simply the tip magazine by itself. The pipettor head and tip magazine must be the same as the ones selected in the Change Pipettor and Tips.

Caution: Failure to select the proper piston head and tip combination will cause the tips to crash into plates and stages and will result in improper volume accuracy.

Step Selection	Action
Show steps to change :- ☒ Pipettor and tips ☐ Tips only	Select the steps required in 'Step Selection' (left) then use the Start button to start the process. The process can be stopped at any time via the Stop button.
☒ Remove tip magazine ☒ Loosen pipettor head clamps ☒ Replace pipettor head ☒ Tighten pipettor head clamps ☒ Insert tip magazine ☒ Home pipettor	
	Done Continue Start Stop

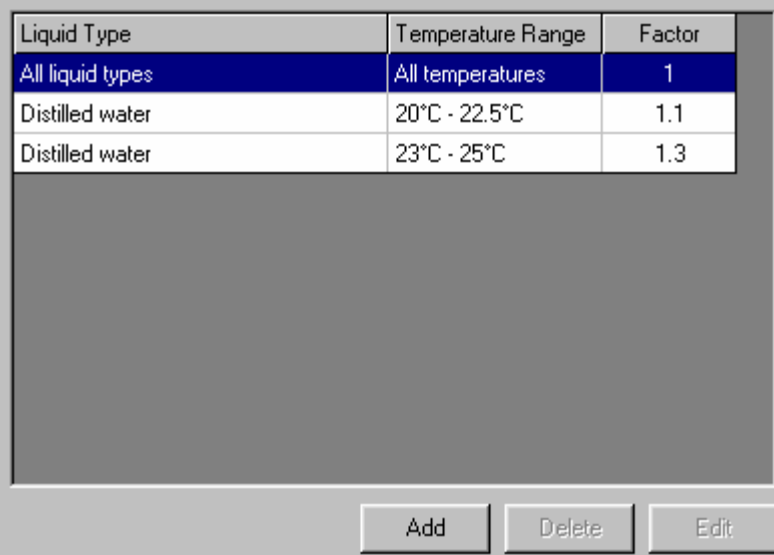
To start the process, select which option is required (change pipettor and or tips to change tip magazine only), then follow the prompts in the “Action” frame. If any errors occur or a step is not successful completed then the status or follow on action will also be displayed in the “Action” frame.

It is possible to stop the process at any time and also possible to process any particular step at any time by checking the check boxes of the steps required. Typically though all actions will be defined by the selection of one of the two radio buttons to define the full set of actions required.

Volumetric Calculation

It is possible to set a volumetric factor to use within the Aspirate and Dispense commands. The factor can be used to cause the piston motor to increase or decrease the number of steps required in order to achieve an accurate volume movement based on liquid sample type and also by environment operating temperature. This will assist in achieving very accurate volume dispensing.

The factors are generated by using a standard volumetric correction factor for the specific liquid type at the temperature range required and to use this applied to the gravimetric measurement taken for the required volume. The net result will be the factor that will be used to correct the piston motor to achieve the required accuracy for the specific liquid/temperature range.



Liquid Type	Temperature Range	Factor
All liquid types	All temperatures	1
Distilled water	20°C - 22.5°C	1.1
Distilled water	23°C - 25°C	1.3

This dialogue is used to create the table in which these volumetric setting are held. To add a new entry select the add button. To delete an existing entry select the delete buttons to amend an entry either double click or highlight it and select the edit button.

Measurements

Whether adding or amending an entry the following dialogue will be displayed.

Sample	Weight (mg)	Volume (ul)
1		
2		
3		
4		
5		
Average		

Fields**Liquid type**

A descriptive text field to identify the liquid type.

Temperature

A descriptive text field to identify the liquid type.

Temperature

Minimum and maximum temperatures, in Celsius, for the current entry.

Calibration volume

The required volume to achieve (programmed dispense volume).

Conversion factor

This is a factor used for converting milligrams of weight to microliters at a specific barometric pressure (i.e. sea level 14.7 bar).

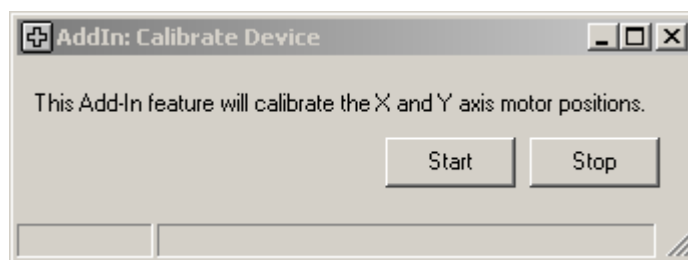
Weight grid

This is used to enter the gravimetric values for each test sample. The volume associated with the weight (calculated by using the conversion factor) is displayed alongside the entry.

Motor Steps factor

This calculated field represents the value that will be used for all commands if the current entry is selected in the command as the volumetric entry to use.

Calibrate Device



The device must first be calibrated to set the X and Y axis settings within the EPROM memory. This option will perform this automatically in 0.01 increment steps and need only be done once for each device.

Fields

Start

Starts the calibration process.

Stop

Will stop the current calibration process. If the process is stopped before it completes then X and Y position accuracy will be compromised.

3.5 Previewing Pipetting Programs

3.5.1 Print Preview

The print preview dialogue menu is used to view and produce a printed report of the current sequence file. The name of the current sequence file is shown in a panel at the foot of the main application window.

Toolbar Buttons

-  *First Page*
Displays the first page of the report.
-  *Previous Page*
Displays the previous page.
-  *Next Page*
Displays the following page.
-  *Last Page*
Displays the last page of the report.
-  *Print*
Sends the report to the selected printer.
-  *Printer Setup*
Allows the user to change the printer properties.
-  *Help*
This help page.

3.6 Processing Programs

3.6.1 File Validation

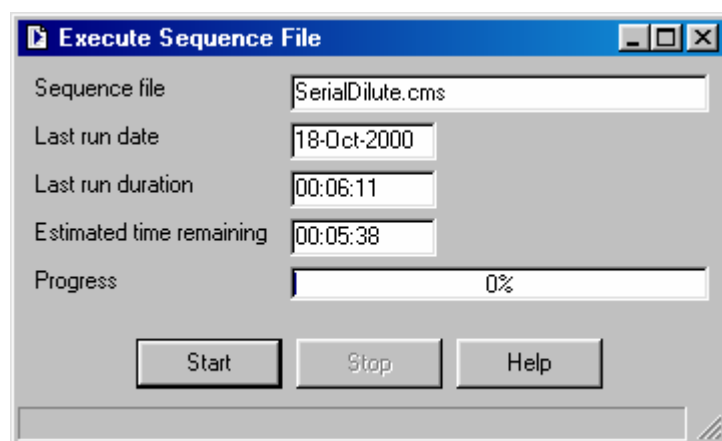
Command values and relationships are checked for errors using the File Validation option. Any individual field errors and relationship errors are listed. It is possible to highlight an error and then display the command in the sequence file editor window in order to make corrections.

Command Buttons

- *OK*
Closes the dialogue window.
- *Show*
Jumps to the highlighted command in the sequence file editor window.
- *Help*
This help page.

3.6.2 File Execution

The File Execution dialogue controls the **Thermo Scientific Matrix PlateMate 2x3** device using the sequence file from the current Sequence File Editor window. The name of the file for the current window is shown on the status bar at the foot of the main application window.



Fields

- *Sequence File*
Name of the file in the current Sequence File Editor dialogue.
- *Last Run Date*
Date the file was last executed on the device.
- *Last Run Duration*
The duration of the last execution for this file.

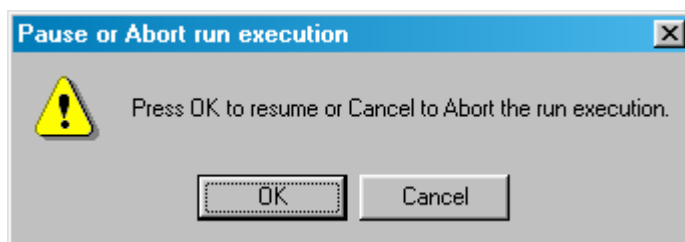
- *Estimated time remaining*
An estimation of the amount of running time left for the current sequence file execution. This is based on the current duration with reference to the Last Run Duration.

Command Buttons

- *Start*
Start processing the sequence file.
- *Stop*
Pause or Abort File Execution.
- *Help*
This help dialogue.

Pause or Abort File Execution

When Stop button is clicked on the File Execution the following dialogue will be shown.



Command Buttons

- *OK*
Continues with the file execution.
- *Cancel*
Aborts the file execution.

4 System Operation

The **Thermo Scientific Matrix PlateMate 2x3** instrument and **ControlMate** software are tightly integrated to provide an efficient system of transferring, diluting, and mixing fluids. This section covers both instrument and software tasks that are required to set up and run the **Matrix PlateMate 2x3**.

4.1 Introduction

This chapter consists of the following sections:

- ◆ Setting up **Thermo Scientific Matrix PlateMate 2x3**
- ◆ Running Pipetting Program
- ◆ Shutting Down

Setting up Thermo Scientific Matrix PlateMate 2x3

Proper setup of **Thermo Scientific Matrix PlateMate 2x3** is critical to the accuracy and precision of the pipetting run; therefore, most of this chapter is devoted to instrument setup. Section 4.2 contains all instrument setup procedures.

Running Pipetting Program

After the **Thermo Scientific Matrix PlateMate 2x3** is set up, it is ready to run a pipetting program. Section 4.3 describes a sample pipetting program.

Shutting Down

Section 4.4 contains a checklist of tasks to shut down the instrument.

Note: To avoid instrument damage and ensure optimal performance of your pipetting program, use the pipettor head, and D.A.R.T.s tips that are appropriate for the program and accessories to be used. All instrument setup procedures are described in this chapter.

4.2 Setting Up *Thermo Scientific Matrix PlateMate 2x3*

Before the ***Thermo Scientific Matrix PlateMate 2x3*** can be used to run a pipetting program, it must be set up with the correct pipetting head, D.A.R.T. tips, reservoirs, and tip wash.

The setup procedures are listed below.

- ❑ Change pipettor head* (see Section 4.2.1)
- ❑ Change D.A.R.T. tips* (see Section 4.2.2)
- ❑ Attach Reagent Reservoir (see Section 4.2.3)
- ❑ Attach Tip Wash Station (see Section 4.2.4)
- ❑ Attach fluid lines for reagents, buffers, wash solution, and waste container (see Section 4.2.5)

Not all of the setup procedures are needed for each pipetting run. The following procedures are included for special situations that require undefined microplates (not in the plate library) or stage adjustments:

- ❑ Define new plate types* (see Section 4.2.6)
- ❑ Calibrate stage positions* (see Section 4.2.7)

Each procedure is described in more detail in the sections that follow. Refer to the section that applies to the pipetting program you will be using.

Note: If this is your first time running the ***Thermo Scientific Matrix PlateMate 2x3***, review all of the sections to better understand when you would use each procedure.

* The indicated procedures are software-controlled and require both the ***Thermo Scientific Matrix PlateMate 2x3*** and ***ControlMate*** software to be running.

4.2.1 Changing Pipettor Head and Tips

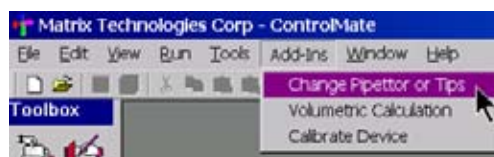
The **Thermo Scientific Matrix PlateMate 2x3** can accommodate various pipettor heads, providing different volume ranges for either 96-channel or 384-channel formats.

The **ControlMate** Software contains step-by-step instructions to change the pipettor head and tips. The steps are also documented below. Each step is described in the left column and illustrated with picture or screen in the right column.

For details on each option or field shown in the screens, refer to *Chapter 4, ControlMate Software*.

1. Start the **Thermo Scientific Matrix PlateMate 2x3** and **ControlMate** software.

2. In **ControlMate**, select “Add-Ins” > “Change Pipettor or Tips” from the Toolbar.



3. Select the pipettor head configuration and tip combination you will be installing.

Important: Be sure to select the correct tip combination that corresponds to the pipettor head configuration.

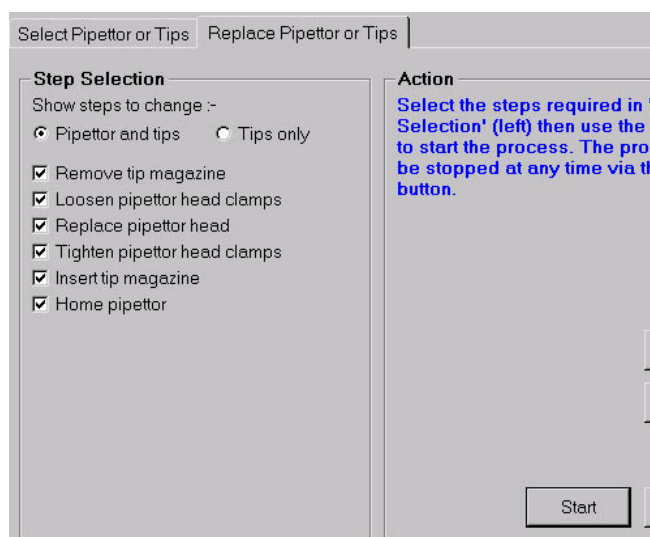
Many preset height movements are based on the physical characteristics of the tips. Using the incorrect D.A.R.T. combination will cause the microplates and stages to crash into the tips and will result in improper volume accuracy.

A screenshot of the 'Select Pipettor or Tips' dialog box in the ControlMate software. The dialog has two tabs: 'Select Pipettor or Tips' (active) and 'Replace Pipettor or Tips'. Under the active tab, there are several settings: 'Configuration' is a dropdown menu showing '384 0.1 ul - 12.5ul standard tips (5301+5302)'; 'Tip count' is '384'; 'Tip diameter' is '48'; 'Wash depth' is '1200'; 'Volume range' is '0.1 to 12.5' with an 'Increment' of '0.1' ul; 'Piston' is '150' with a '1/100 mm' scale; 'Incremental column movement' is unchecked, and 'Incremental row movement' is checked; 'Aspirate overstroke' is '5' ul; 'Max blow out volume' is '5'; 'Tip removal height' is '1050' with a '1/100 mm' scale and a blue arrow icon; 'Tip bottom height' is '14400' with a '1/100 mm' scale and a blue arrow icon; 'Piston clamp height' is '500' with a '1/100 mm' scale and a blue arrow icon; 'Piston remove height' is '300' with a '1/100 mm' scale and a blue arrow icon; 'Piston lock height' is '8000' with a '1/100 mm' scale and a blue arrow icon; 'Piston speed' is set to 'Slow' with a slider between 'Slow' and 'Fast'; and a 'Reset To Default' button is on the right.

4. Click “OK” to save the selection.

5. Select “Add-Ins”>”Pipettor and Tips” again and select the tab, “Replace Pipettor and tips”.
6. The steps required to replace both the pipettor head and the tips are shown in the Step Selection box in the order they should be performed.

All the steps are required for this procedure; therefore, they are all automatically checked.



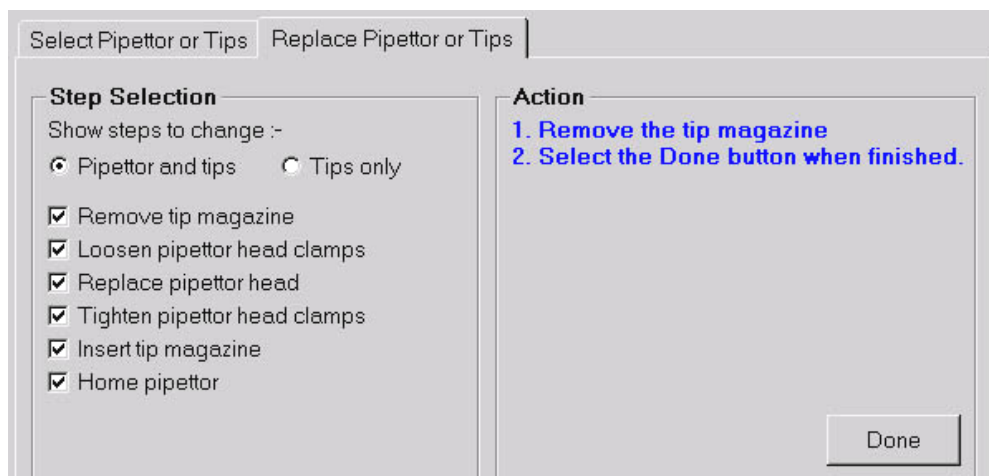
Note: Do not lift the pipettor head housing cover until instructed to do so. The pipettor head housing contains a safety sensor that stops pipettor head movement when the hood is opened.

Contact sensors on back of hood door and top of hood.



7. Click “Start”.

The screen will remain displayed as the instructions in the Action box, shown in blue text, guide you through each step.



4.2 Setting Up Thermo Scientific Matrix PlateMate 2x3

8. Remove the tip magazine, then select “Done” on the **ControlMate** screen.

The piston motor moves down to loosen the tip magazine clamp.

The software screen briefly describes each instrument action as it is performed.

Action
Releasing the tip magazine clamp.



9. Read the next set of steps described in the screen.

Select Pipettor or Tips	Replace Pipettor or Tips
Step Selection Show steps to change :- ☒ Pipettor and tips ☐ Tips only ☒ Remove tip magazine Done ☒ Loosen pipettor head clamps ☒ Replace pipettor head ☒ Tighten pipettor head clamps ☒ Insert tip magazine ☒ Home pipettor	Action 1. Open the pipettor head housing door. 2. Loosen and disengage the 4 top piston head clamps. 3. Close the pipettor head housing door. 4. Select the Done button when finished, this will cause the motor to move. Done

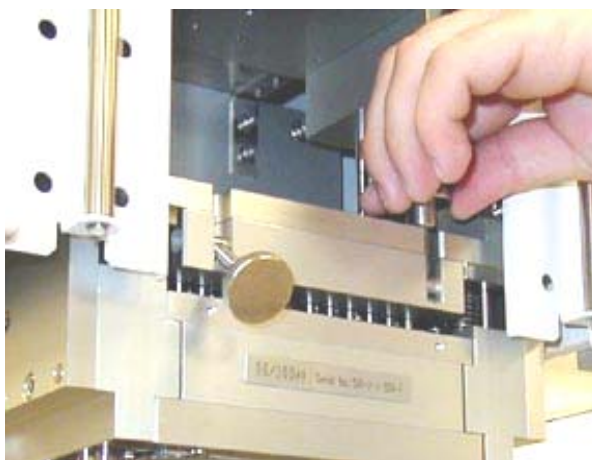
10. Lift the pipettor head housing door of the **Thermo Scientific Matrix PlateMate 2x3**.



11. Loosen the four clamps that secure the pipettor head to the frame. Turn the clamps counter-clockwise to loosen.

Once loosened the front screws will swivel forward and the rear screws will swivel to the back.

Caution: Move the screws so that they are clear of the piston mechanism (rear screws) and clear of the front cover (front screws)



12. Close the pipettor head housing door.

13. Select "Done" in the **ControlMate** screen.

The motor will move the pipettor head down for removal.



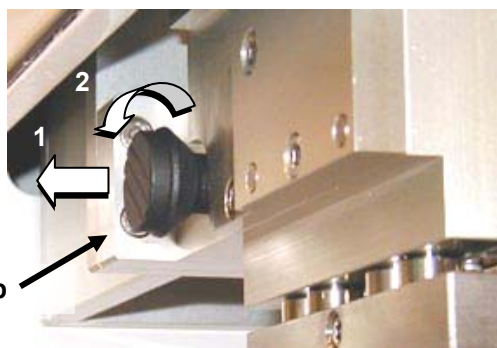
14. Read the next set of steps described in the screen.

Select Pipettor or Tips	Replace Pipettor or Tips
Step Selection	
Show steps to change :-	
☒ Pipettor and tips ☐ Tips only	
☒ Remove tip magazine	Done
☒ Loosen pipettor head clamps	Done
☒ Replace pipettor head	
☒ Tighten pipettor head clamps	
☒ Insert tip magazine	
☒ Home pipettor	
Action	
1. Disengage piston head alignment knobs.	
2. Remove and replace the piston head.	
3. Re-engage the piston head alignment knobs.	
4. Select the Done button when finished, this will cause the motor to move.	
Done	

4.2 Setting Up Thermo Scientific Matrix PlateMate 2x3

15. Pull out the alignment knobs on both sides of the pipettor housing and turn knobs approximate $\frac{1}{4}$ turn in either direction to unlock the pipettor head.

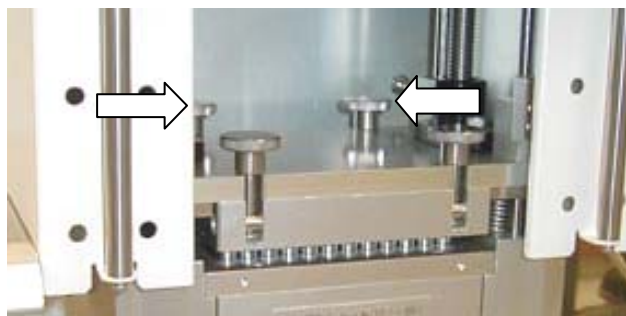
Alignment Knob



16. Lift the pipettor head housing door.
17. Grasp the front end of the pipettor head firmly and slowly pull it out of the frame.
18. Insert the replacement pipettor head.



Warning: Lift the screws at the back of the pipettor head to keep them clear of the piston mechanism as you push the pipettor head into place.



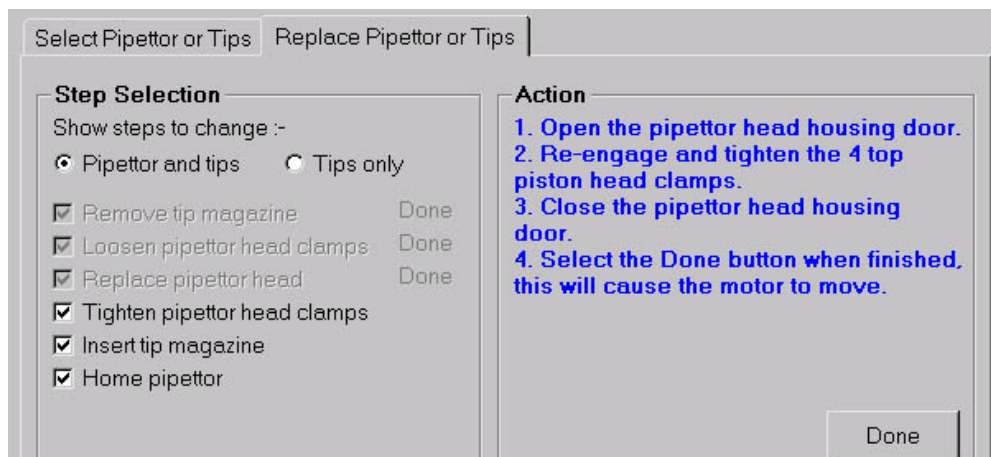
19. Turn both alignment knobs until they slip into the pipettor head and lock it in place.
20. Close the pipettor head housing door.

Note: If you do not close the housing door prior to the next step, you will receive an error message.



21. Select "Done".

22. Read the next set of steps described in the screen.



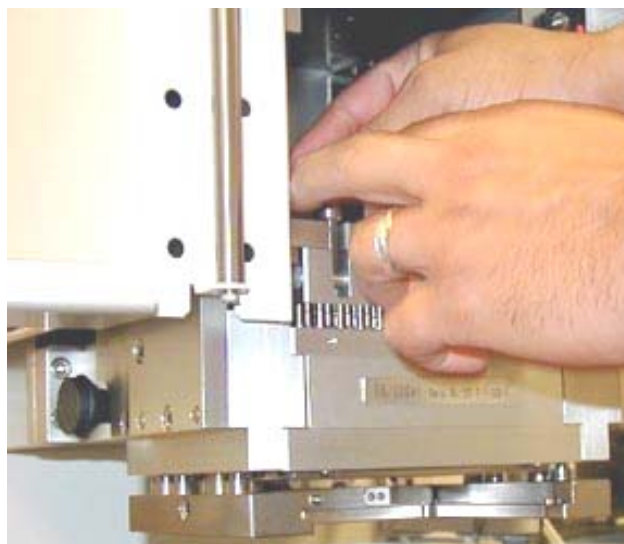
23. Lift the pipettor head housing door.

24. Hand-tighten all four knobs. Turn the clamps clockwise to tighten.

25. Close the pipettor head housing door.

26. Click "Done".

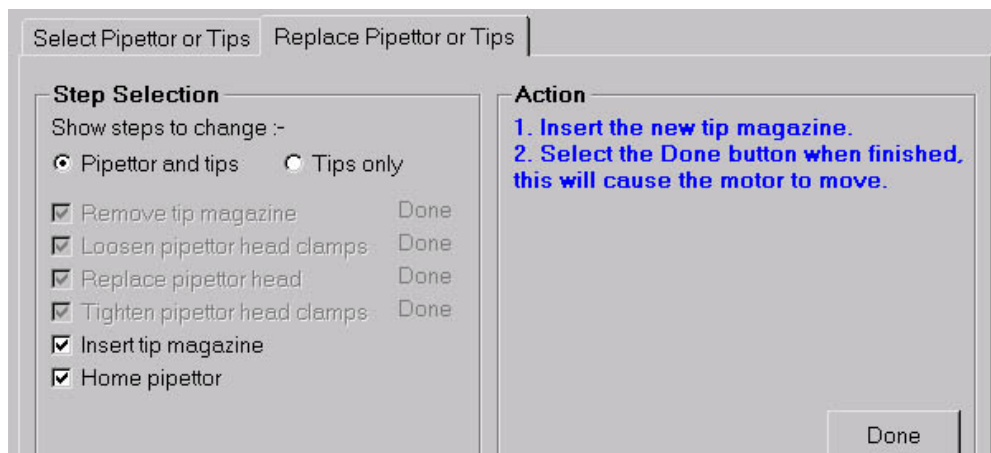
Caution: To avoid damage to the instrument, ensure that the clamps are securely fastened and that the pipettor head housing door is closed before clicking "Done".



The system releases the tip magazine clamp to receive the new tip magazine.

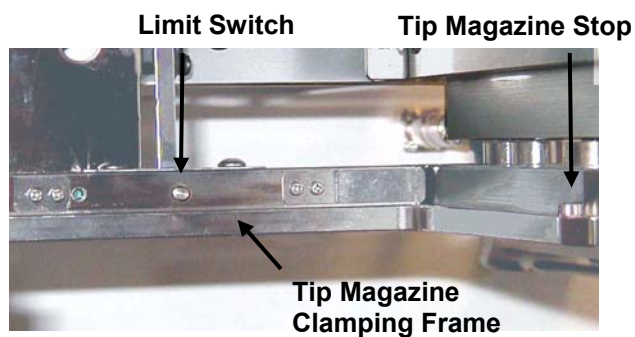
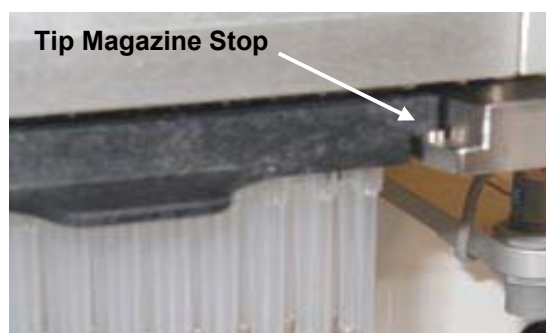
4.2 Setting Up Thermo Scientific Matrix PlateMate 2x3

27. Read the next set of steps described in the screen.



28. Insert the new tip magazine.

Note: Seat the tip magazine firmly behind the Tip Magazine Stop to ensure that the limit switch (back of the clamping frame) is activated by the tip magazine.



29. Select "Done".

The system resets the pistons to the home position.

The **Thermo Scientific Matrix PlateMate 2x3** is ready to run your pipetting program.

4.2.2 Changing Pipet Tips Only

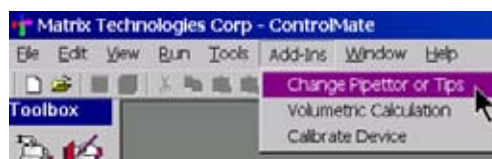
Pipet tips can be replaced quickly and easily in the **Thermo Scientific Matrix PlateMate 2x3**. Tips can be changed *before* a run or *during* a run. The **ControlMate** software guides you through each step. For details on each screen, refer to *Chapter 4, ControlMate Software*.

Use the following procedure to manually change pipettor tips. Each step is described in the left column and illustrated with picture or screen in the right column.

Note: For details on each option or field shown in the screens, refer to *Chapter 4, ControlMate Software*.

1. Start the **Thermo Scientific Matrix PlateMate 2x3** and **ControlMate** software

2. In **ControlMate**, select “Add-Ins >Change Pipettor or Tips” from the Toolbar.

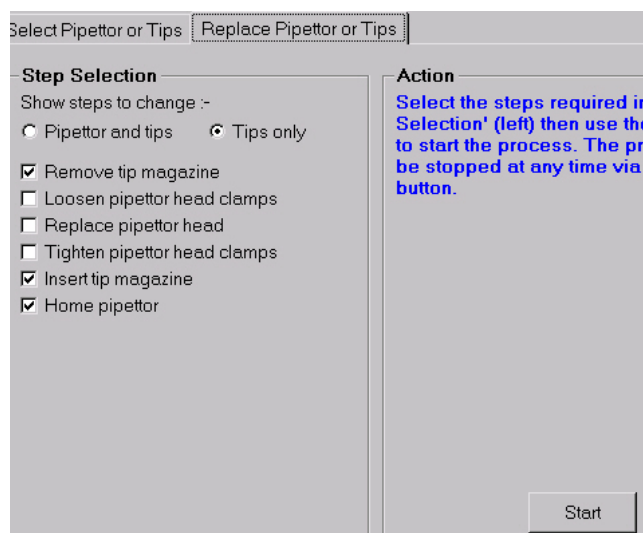


3. Click “Replace Pipettor or Tips” tab.

4. Select “Tips only”. Only the steps associated with changing tips are checked in the Step Selection box.

The steps are shown in the Step Selection box in the order they should be performed.

Note: Ensure that the pipettor head housing door is closed before proceeding to the next step.



5. Click “Start” to begin the instrument process.

The screen will remain displayed as the instructions in the Action box, shown in blue text, guide you through each

4.2 Setting Up Thermo Scientific Matrix PlateMate 2x3

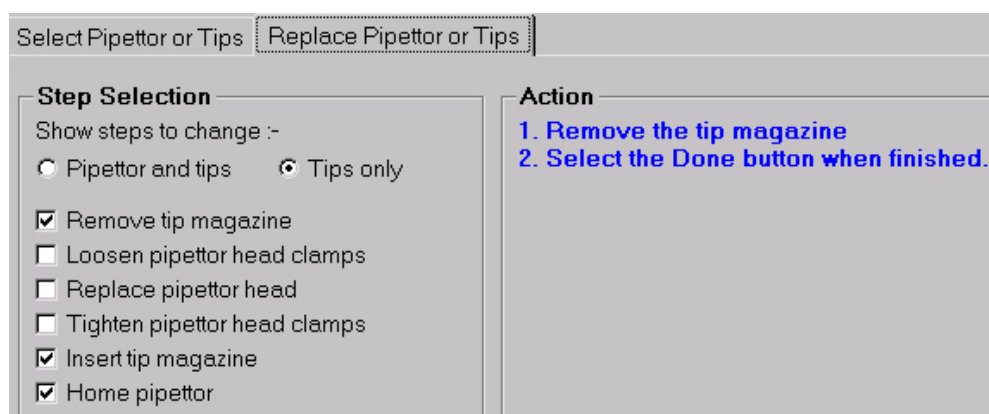
step.

The piston motor loosens the tip magazine clamp.

The software screen briefly describes each instrument action as it is performed.



6. Read and follow the steps on the screen.



7. Remove the old tip magazine from the instrument.
8. Click "Done".



9. Read and follow the steps on the screen.

Select Pipettor and Tips Replace Pipettor or Tips

Step Selection

Show steps to change :-

☐ Pipettor and tips ☒ Tips only

☒ Remove tip magazine Done

☐ Loosen pipettor head clamps

☐ Replace pipettor head

☐ Tighten pipettor head clamps

☒ Insert tip magazine

☒ Home pipettor

Action

1. Insert the new tip magazine

2. Select the Done button when finished, this will cause the motor to move.

Done

10. Insert the new tip magazine.

11. Click "Done".

The system resets the pistons to the home position, clamping the tips

The **Thermo Scientific Matrix PlateMate 2x3** is ready to run your pipetting program.

4.2.3 Onboard Reagent Filling

The **Thermo Scientific Matrix PlateMate 2x3** provides onboard reagent filling and level-sensing. Stationary sensor brackets on each side of the pipettor head hold the filling nozzles and liquid-level sensors over the reagent reservoirs for automated filling and noncontact liquid-level sensing (see figure below).

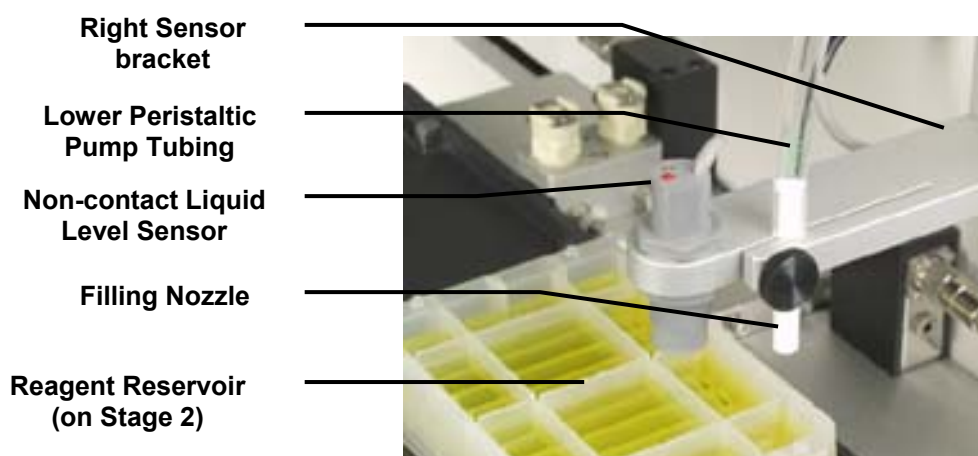


Figure 4-1: Right Sensor Bracket and Reagent Reservoir

The Reagent Reservoir can be placed on Stage 1 and automatically filled by a filling nozzle inserted in the **left** sensor bracket and attached to the upper peristaltic pump. A second Reagent Reservoir can be placed on Stage 2 and automatically filled by a filling nozzle in the **right** sensor bracket and attached to the lower peristaltic pump. The non-contact liquid-level sensor in each bracket ensures that each reservoir is filled to a predefined volume every filling cycle.



Figure 4-2: Reagent Filling Components

Chapter 4 System Operation

Reagent reservoirs for 96-well and 384-well pipetting are available (see following table). The **Thermo Scientific Matrix PlateMate 2x3** can also use the following disposable reagent reservoirs.

Catalog No.	Capacity	Material
1064-05-8	96-channel, 125mL, Non-Sterile	Polypropylene
1064-15-8	96-channel, 125mL, Sterile	Polypropylene
1064-05-6	96-channel, 200mL, Non-Sterile	Polypropylene
1064-15-6	96-channel, 200mL, Sterile	Polypropylene
1064-05-7	384-channel, 65mL, Non-Sterile	Polypropylene
1064-15-7	384-channel, 65mL, Sterile	Polypropylene

Attaching Fill Reservoir

1. Place the Reagent Reservoir on platform Stage 1 or 2.

Note: If the Tip Wash Station is used, it must be placed on Stage position 2.

Stage 2

Stage 1

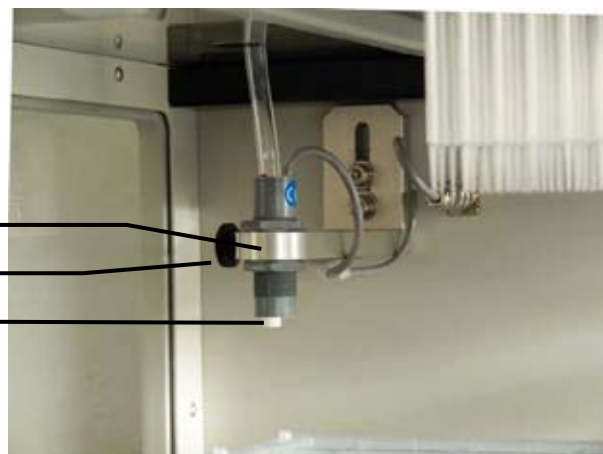


2. Insert the filling nozzle of the reagent tube into the hole in the non-contact sensor bracket and secure it by turning the adjustment screw.

Non-contact sensor bracket

Adjustment screw

Filling nozzle



4.2 Setting Up Thermo Scientific Matrix PlateMate 2x3

3. Manually fill the reagent reservoir to the desired fill height.
4. Use the **Move** command to move the filled reservoir under the liquid-level sensor.

Note: The closer the level sensor is to the liquid, the more accurate the level sensing.

Adjust the liquid level sensor with a small screwdriver. Turn the screw clockwise until the sensor light turns on (**red LED in sensor turns on when it detects liquid**). Turn the screw slightly in both directions until the light turns off—then back on—to fine tune the sensor.

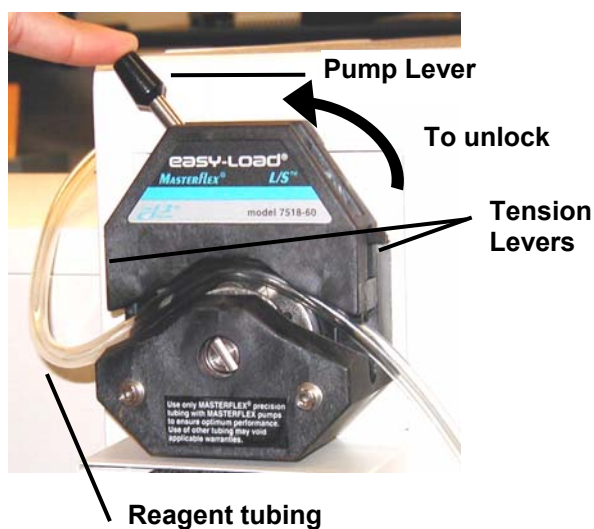
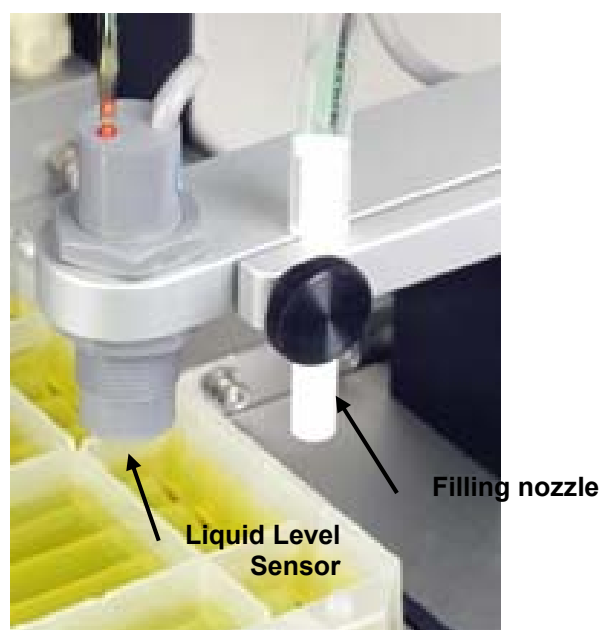
To double-check the sensor, rock the reagent reservoir slightly. The sensor light should remain on.

Once set, the liquid level sensor will stop reagent filling when the reagent reaches this fill height.

5. Place the reagent tubing into the peristaltic pump (top for left sensor bracket or bottom for right sensor bracket), then into the reagent or buffer container.

Note: Both pumps can be used to fill either of the two reagent reservoirs, as long as the tip wash station is not required.

To insert tubing, unlock the pump by moving the locking

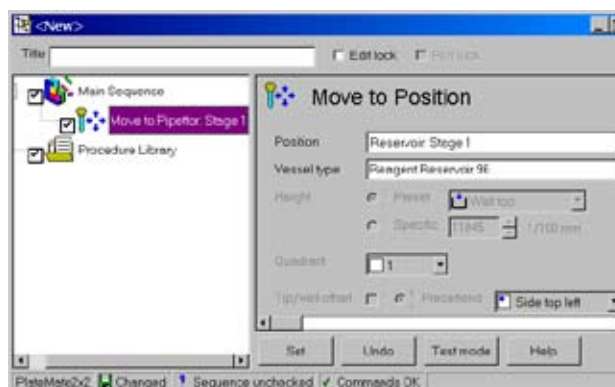


pump lever to the left side of the pump. Return the lever to the right side to lock the tubing in place. If necessary, adjust the tension levers on both sides of the pump to prevent slippage.

6. In **ControlMate**, select “Move to Position” from the Toolbox.

“Toolbox>Move to Position:”

- In the *Move to Position* drop-down menu, select “Reagent Reservoir Stage 1”.
- In *Vessel Type*, select the appropriate reagent reservoir.



During a pipetting sequence, the system pumps reagent through the filling nozzle. The liquid-level sensor prevents overflow by signaling the pump when to stop

The reagent reservoir is ready to be used in the next pipetting sequence.



4.2.4 Using the Tip Wash Station

The Tip Wash Station allows you to wash both the interior and exterior walls of D.A.R.T. tips, positive displacement pipetting heads, and stainless steel probes. It connects to the wash peristaltic pump to dispense clean wash fluid and waste vacuum line to remove the used fluid. Through the **ControlMate** software, you can specify the number of wash cycles and the wash volume. The Tip Wash Station comes with a separate area to receive waste liquid, thereby minimizing contamination during the wash step.



Figure 4-3: Tip Wash Station, 96-Channel Tall

Tip Wash Stations are available for 96-channel and 384-channel pipettor heads, in two different heights: 'Short' (for standard tips) and 'Tall' (for extended length tips and positive displacement heads). All tip wash stations are made of PTFE with Stainless Steel Chimneys.

Refer to the following table for order information.

Catalog No.	Capacity	Material
801-20961	96-channel, Standard Height	PTFE/Stainless Steel
801-20962	384-channel, Tall Height	PTFE/Stainless Steel
801-23841	96-channel, Standard Height	PTFE/Stainless Steel
801-23842	384-channel, Tall Height	PTFE/Stainless Steel

Attaching the Tip Wash Station

1. Place the Tip Wash Station on platform stage 2. Ensure that the sensor cable is to the front. The inlet and outlet barbs on the bottom will automatically engage with their corresponding ports.

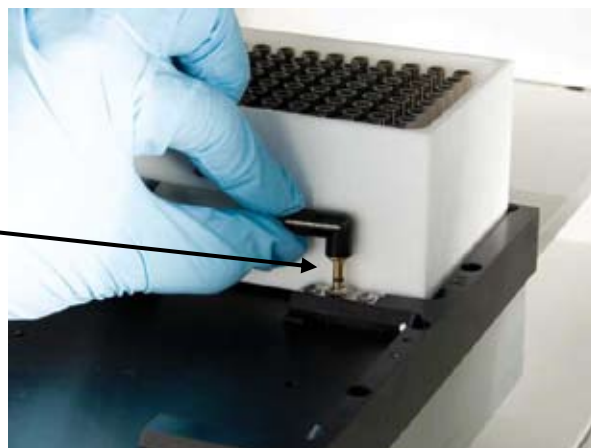
Note: The Tip Wash Station can only be used on platform stage 2.



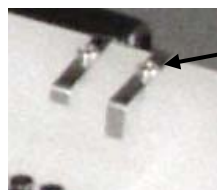
Tip Wash Station

2. Insert the contact sensor cable from the Wash Station into the sensor port in the deck.

Wash Station Sensor Port



3. The Tip Wash sensor detects liquid overflow using a conductive contact sensor and serves as a safety backup in case the vacuum pump stops.



Contact Liquid Level Sensor on Wash Station

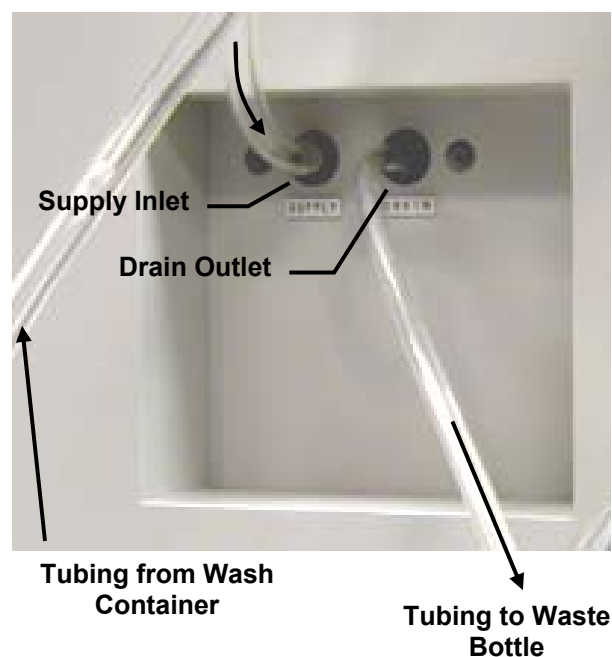
4.2 Setting Up Thermo Scientific Matrix PlateMate 2x3

4. Insert one end of the wash tubing into the Supply Inlet, place the tubing into the lower peristaltic pump, then insert the other end of the tubing into the wash container.

5. Insert one end of the waste tubing into the Drain Outlet and the other end into the waste bottle.

The system pumps clean wash liquid into the tip wash station through the lower peristaltic (wash) pump.

The system then removes the waste liquid from the tip wash station using a vacuum pump (internal, not shown). The waste liquid exits from the Drain Outlet to the waste container.



- In **ControlMate**, select “Move to Position” from the Toolbox.

Toolbox>Move to Position:

- In the *Move to Position* drop-down menu, select “Pipettor Stage 2”.
- In *Vessel Type*, select “Tip wash 96 well” or “Tip wash 384 well”.

Note: To dispense waste liquid into the waste bath instead of the washing channels, select the tip wash “into waste bath” option.

- In *Height*, select a preset filling height or enter a height.

- Select “Tip Wash” from the Toolbox.

Toolbox>Tip Wash:

- In *Cycles*, select the number of wash cycles.
- In *Volume*, select the wash volume.
- Adjust *Pump speed* according to tip size.
- Specify dispense location for waste liquid: into chimneys or into waste bath.
- Select “Blowout” if you want to expel the remaining liquid.

- Click “Set” to save the settings.

Note: Do not use the dispense option “Into waste bath” if you selected “Tip wash 96 (or 384) well” in the Move to Position command. The tip wash cycle will not operate.

This dispense option works only when you select “Tip wash 96 (or 384) well into waste bath” in the Move to Position command.

Tip Wash Sequence

The system moves the tip wash station up to the D.A.R.T.s tips until they are inserted into the wash channels. Refer to the diagram on the right.

Step 1: The wash fluid enters through the wash channels to clean the outside of the pipet tips and spills into the surrounding basin. The pipet tips expel any liquid remaining in the tips.

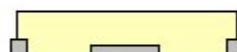
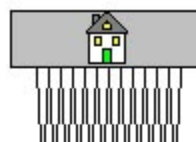
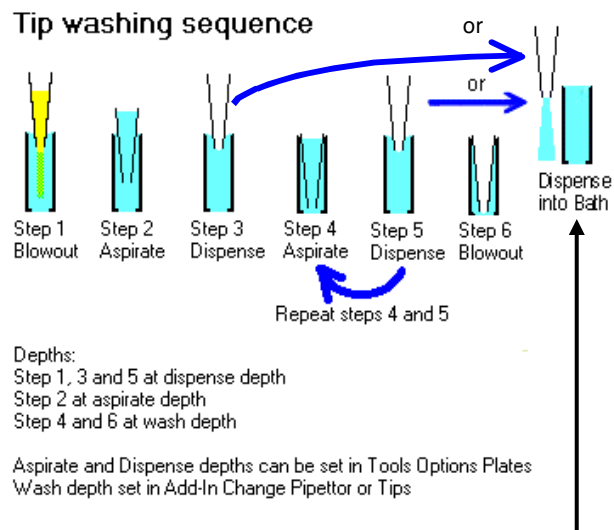
Note: If the waste bath option is selected, the tips move to the outside of the channels before expelling waste liquid.

Steps 2 and 3: At the same time, the system aspirates and dispenses wash fluid (into the channel or waste bath) to clean the inside of the tips.

Steps 4 and 5: Fluid aspiration and dispensing is repeated for each wash cycle.

Step 6: The tips expel any remaining liquid.

Step 7: The pipetting head rises while the vacuum pump drains the waste fluid from station.



Step 7
 Lower stage to zero height and then
 reset piston to home position

The tips are clean and ready to be used in the next pipetting routine.

CAUTION! Although tip washing significantly reduces sample carryover by rinsing both the internal and external walls of the D.A.R.T.s tips, carryover is never completely eliminated. To ensure zero carryover it is recommended that D.A.R.T. tips be replaced between sample transfers. This can be done manually (by an operator) or automatically by using the Thermo Scientific Matrix Tip Tower (an automated tip changing device).

4.2.5 Overview of Fluid Lines

Previous sections showed specific fluid line attachments for the reagent reservoir and tip wash station. This section provides an overview of fluid lines in the **Thermo Scientific Matrix PlateMate 2x3**.

The following illustration shows the pathway of the various fluid lines throughout the instrument. Solid lines represent tubing outside of the instrument; broken lines represent tubing inside the instrument.

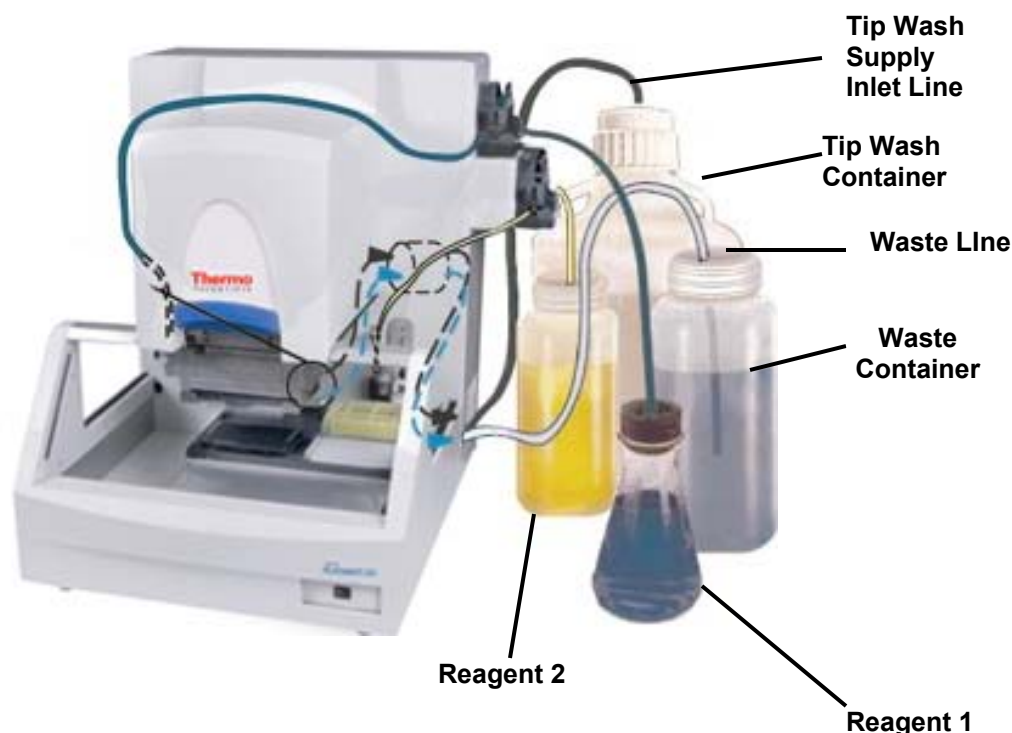


Figure 4-4: Overview of Fluid Lines

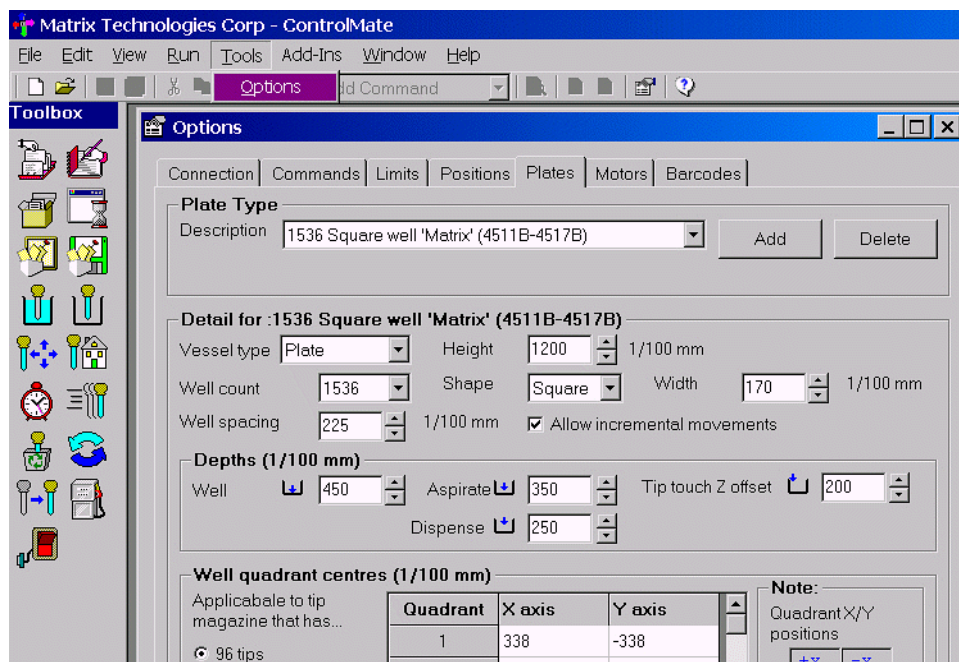
Fluid Line	Description
 Reagent 1	Reagent 1 flows from the Reagent 1 flask, through the top peristaltic pump, into the left filling nozzle, and to the reagent reservoir on stage position #1.
 Reagent 2	Reagent 2 flows from the Reagent 2 bottle, through the bottom peristaltic pump, into the right filling nozzle, and to the reagent reservoir on stage position #1 (or stage position 2 if Tip Wash Station is not used).
 Tip Wash	Tip Wash solution is drawn into the Supply Inlet by the Vacuum Pump and flows to the Tip Wash Station (stage 2 only).
 Waste	Waste fluid is removed from the Tip Wash Station by the Vacuum Pump, exits via the Drain Outlet, into the Waste Container.

4.2.6 Defining New Plate Types

The **Thermo Scientific Matrix PlateMate 2x3** comes with a library of commonly-used microplate types and vessel types (for example, reservoirs and tip wash stations). When you select a microplate in the library, the **Thermo Scientific Matrix PlateMate 2x3** uses the stored parameters to properly position that microplate under the pipetting tips. If you use a microplate type that is not in the library, then the instrument may need to be retaught to ensure optimal pipetting position and performance.

Caution! Improper definition of the microplates can cause the pipet tips to crash into the microplate. Be sure to follow the procedure in this section for the microplate type that will be used in pipetting operations.

To ensure accurate pipetting, the vessel type whether it is a microplate, tip wash or even a reagent reservoir must be defined in the plates library. The **Plates** option in the **Tools** menu is used to set the dimensions and well positions for each vessel type.



The detail and number of entries depends on how accurate the stage positioning is required, either by defining a vessel/plate type for each specific type or by a generic group. For example, a single vessel type group can be defined to represent all 96 well plates that are likely to be used. However, a specific vessel type may be required to ensure a higher degree of accuracy for a 1536-well plate.

Note: The parameters entered in the **Plates** option are critical for correct positioning and filling of reagent reservoirs and tip wash stations as well as for specific microplate types.

Use the following procedure to enter a new vessel type or to amend an existing vessel type.

Defining a new plate:

Note: Ensure that the instrument is on and connected to the PC. Also ensure that the correct pipetting head is installed.

1. In the **ControlMate** software, select “Tools>Options”. Select the “Plates” tab to display the following screen.

Plate Type

Description: 1536 Square well 'Matrix' (4511B-4517B) [Add] [Delete]

Detail for : 1536 Square well 'Matrix' (4511B-4517B)

Vessel type: Plate Height: 774 1/100 mm

Well count: 1536 Shape: Square Width: 170 1/100 mm

Well spacing: 225 1/100 mm ☒ Allow incremental column movements

Depths (1/100mm)

Well: 450 Aspirate: 350 Tip touch Z offset: 200

Dispense: 250

Well quadrant centres (1/100 mm)

Applicable to tip magazine that has

- ☒ 96 tips
- ☐ 384 tips
- ☐ 1536 tips

Quadrant	X axis	Y axis
1	338	-338
2	113	-338
3	-113	-338
4	-338	-338

Note: Quadrant x/y positions

+x	-x
-y	-y
+x	-x
+y	+y

Note: Refer to the **ControlMate** help file for information on each field entry and command button.

2. Select the “Add” button. The software will display a blank plate type to allow you to create a new vessel type.

This screen also allows you to copy the plate parameters of an existing vessel type to expedite the creation of the new vessel type. Click in the “Similar to...” window to select an existing plate type from the drop-down menu.

New Plate Type

Description: []

Similar to...: 1536 Square well 'Matrix' (4511B-4517B)

[Apply] [Cancel]

3. Enter the description of the new plate type and make any modifications needed to match the new plate type. Refer to the help file for details on each parameter.
4. Click “Apply” to save the new vessel type.

4.2 Setting Up Thermo Scientific Matrix PlateMate 2x3

You can test the new vessel type by inserting a **Move** command in a **ControlMate** program, then selecting “Test Mode”.

The new vessel type is ready to use. If the vessel type requires different stage positions, then continue to the next section.

4.2.7 Calibrating Stage Positions

The **Thermo Scientific Matrix PlateMate 2x3** comes with a six-position microplate deck that can accommodate different container types that are used in the pipetting operations, such as deep-well or shallow-well microplates.



Figure 4-5: Platform Stages

You can use all six stages to transfer microplates or reserve stages 1 and 2 for the reagent reservoir and tip wash station, respectively. Stages are assigned as follows:

- Stage 1:** Microplate, deep well block, tube rack, or reagent reservoir.
- Stage 2:** Microplate, deep well block, tube rack, reagent reservoir, or tip wash station (Stage 2 only).
- Stage 3:** Microplate, deep well block, tube rack, vacuum manifold or manually filled reservoir. SeptraSeal piercing station.
- Stage 4:** Microplate, deep well block, tube rack, or manually filled reservoir. SeptraSeal piercing station.
- Stage 5:** Microplate, deep well block, tube rack, or manually filled reservoir. SeptraSeal piercing station.
- Stage 6:** Microplate, deep well block, tube rack, or manually filled reservoir. SeptraSeal piercing station.

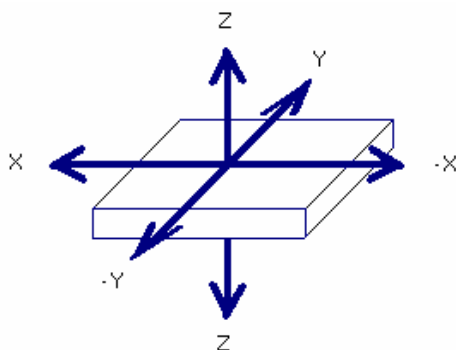
The microplate deck is controlled by two stepper motors, which enable the stage to be moved both laterally (**x**) and front to back (**y**) to position various vessels under the pipet tips.

IMPORTANT: All instruments are calibrated at the factory and should not require adjustment.

Before running a pipetting program, you must calibrate the platform stages to the microplates you plan to use. The calibration procedure aligns the x, y, and z positions of the pipetting head to each stage position. This procedure is critical to pipetting accuracy.

The **Thermo Scientific Matrix PlateMate 2x3** instrument must be calibrated for each stage position and the minimum and maximum limits for each axis at each stage position. This procedure is normally performed during instrument installation; however, if you change microplate types, then the platform positions should be checked and possibly recalibrated to ensure optimal pipetting performance.

Each position on the device has been mapped to a specific stage location, for example, Stage 1 positioned at the pipetting head. Each stage allows for the positioning along 3 axes, which allow for the two (X and Y) associated with the deck positioning and for the tip position (Z axis). These are shown in the following diagram.



The platform positions are calibrated by using the **Options: Positions** dialogue in the **ControlMate** software. The Positions dialogue allows you to reset the minimum and maximum values that a stage can travel on any one of the three axes at any of the defined stage positions. These values will be used within the sequence file editor for each respective command.

Platform Calibration Procedure:

Note: Ensure that the instrument is on and connected to the PC. Also ensure that the correct pipetting head is installed.

1. Insert the D.A.R.T. magazine you plan to use.
2. In the first stage position, insert a microplate.

96-well tips

384-well plate



4.2 Setting Up Thermo Scientific Matrix PlateMate 2x3

Note: To ensure positional accuracy, use a 384-well plate with 96-well tips (or 1536-well plate with 384-well tips). By aligning the D.A.R.T.s tips over the intersection of 4 wells of the 384-well plate, the tips will be correctly centered for the 96-well plate (see figure).

3. In the **ControlMate** software, select “Tools>Options”. Select the “Positions” tab to display the following screen.

Position: Pipettor: Stage 1

Adjust physical location

⚠ Changing any X or Y home values or using the Manual Movement buttons will cause the pipettor head to move.

X home: 100 1/100 mm

Y home: 0 1/100 mm

Move

Test height

5700 1/100 mm

Manual movement

Steps (mm)

0.1, 1, 10, 100

Reset To Factory Default Settings

Offset limits

X offset: -450 to 450 1/100 mm

Y offset: 0 to 450 1/100 mm

Z offset: 0 to 60000 1/100 mm

Allow column incremental movements: ☒

Allow row incremental movements: ☐

Note: Refer to the **ControlMate** help file for information on each field entry and command button.

In this screen, you can enter X and Y values, then press Move to position the pipettor head. Use the Test height to move the pipet head to a safe level after pressing the “Move” button.

You can also use the arrow keys in the Manual movement box to apply incremental changes directly to the pipettor head. The pipettor head responds to each tap of an arrow button. The distance for each tap can be adjusted using the Steps slide bar.

4. Visually check the alignment of the pipet tips to the wells after entering the X and Y values, or while using the arrow keys.
5. Repeat the previous steps for each stage position.

4.3 Running Pipetting Program

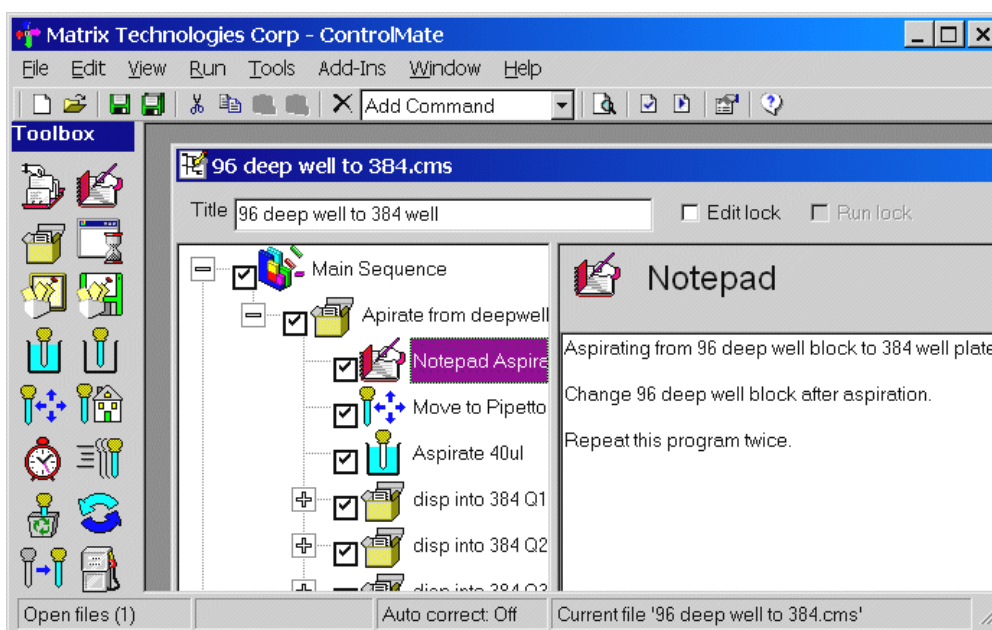
Before starting a pipetting program, review the steps below:

- ❑ Open pipetting program in **ControlMate**. Check instrument setup
- ❑ Attach Reagent Reservoir, if needed (stage 1 and/or stage 2)
- ❑ Attach Tip Wash Station, if needed (stage 2 only)
- ❑ Load microplates
- ❑ Insert or change tip magazine
- ❑ Add ancillaries: reagents, buffers, wash solution, waste container.

When you are ready to start the pipetting program, return to the **ControlMate** screen and perform the following steps

To run a pipetting program:

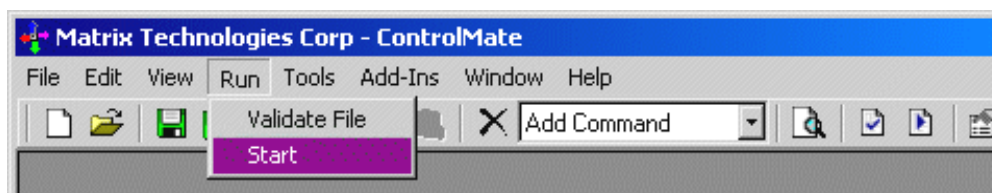
1. Check the “Notepad” for setup instructions or last-minute notes.



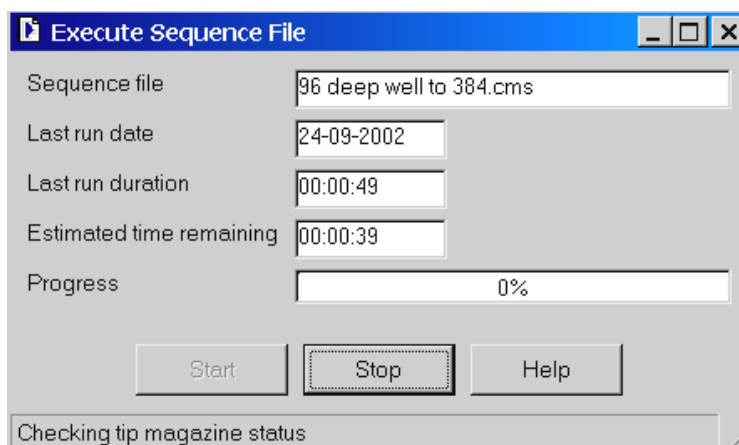
2. Prime buffer or reagent lines.

Note: You can use the Test feature in the Move command to prime buffer or reagent lines.

3. Select “Run”, then “Start” from the Tools Menu.



4. Review the program information in the Execute window and click “Start”.



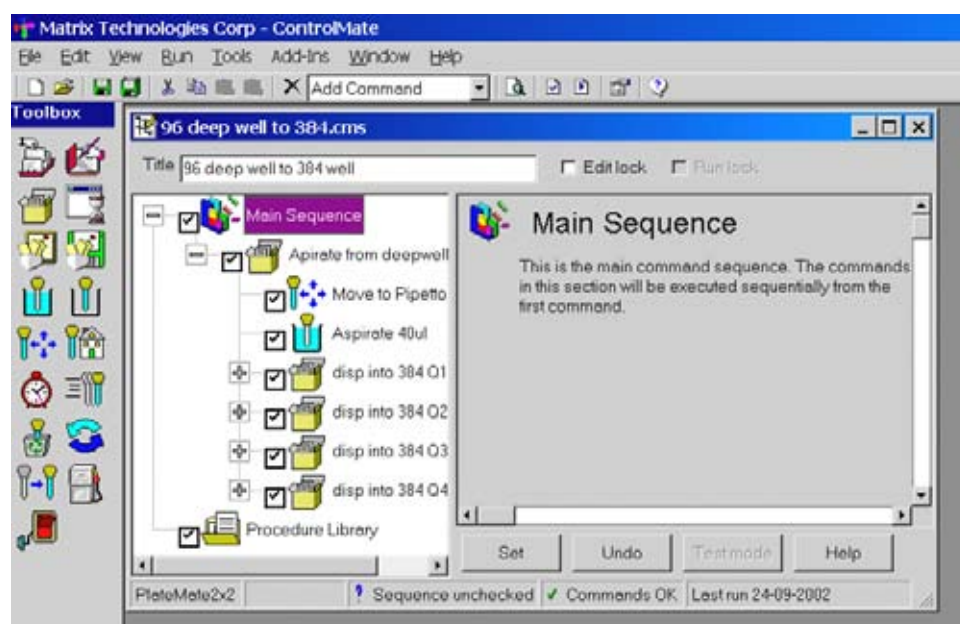
You can watch the percentage completion of the program in the Progress field.

Note: At any time during the pipetting sequence, you can click “Stop” to interrupt the program.

The following sections describe two sample pipetting procedures.

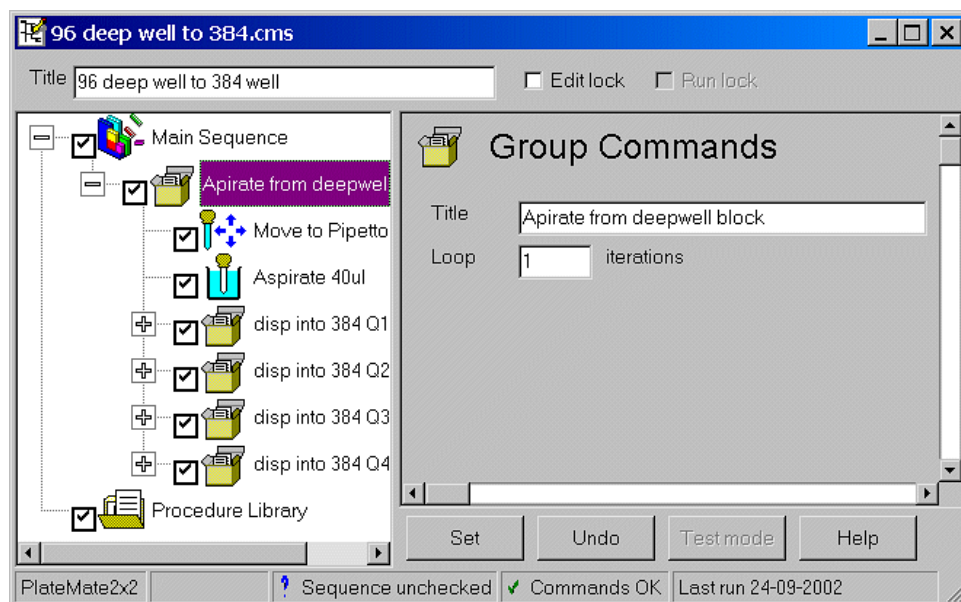
4.3.1 Sample Dispense Program

In this sample program, liquid is aspirated from a deep well block and dispensed into a 384-well microplate:

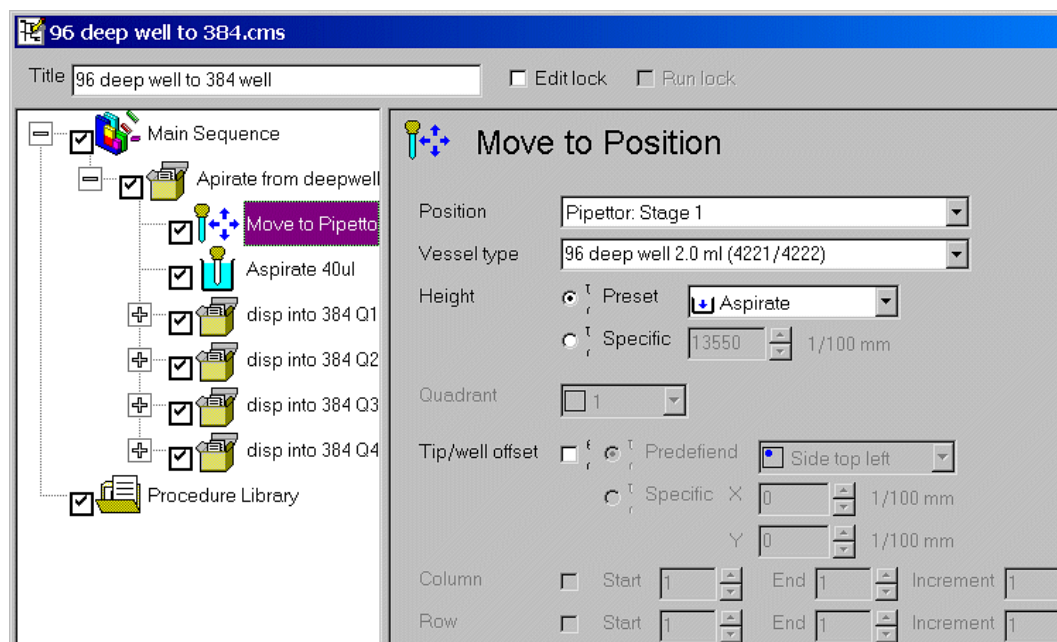


Chapter 4 System Operation

Steps can be grouped according to their function, using the Group Commands icon. Group commands with descriptive titles make the program easy to follow.

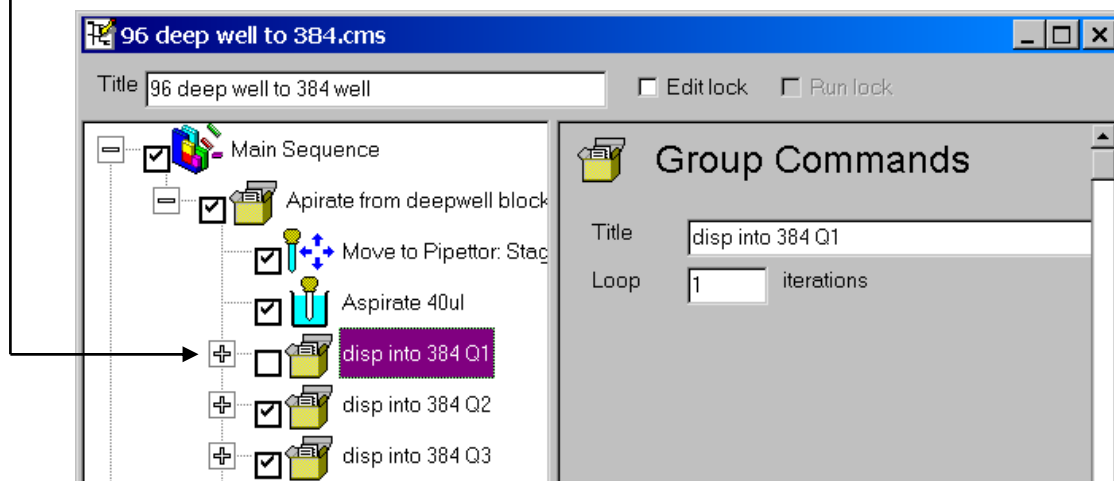


The first step in the group commands is to move to the 96 deep well microplate.

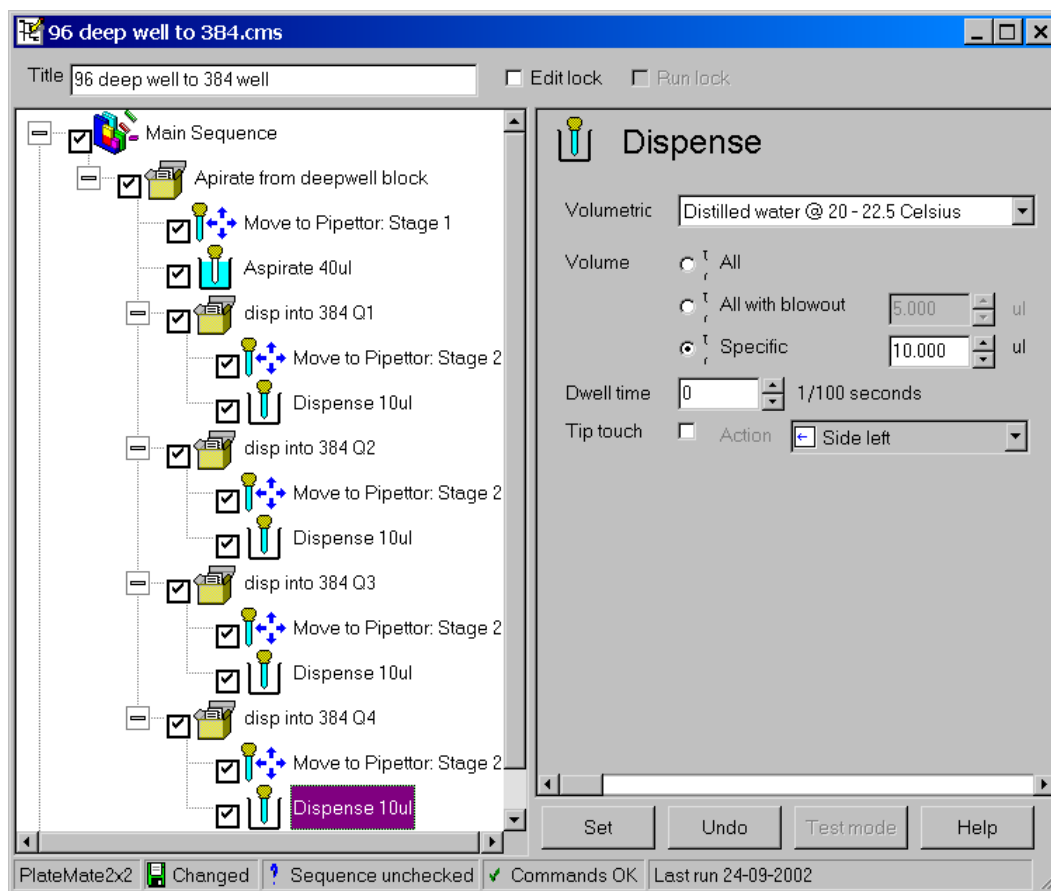


4.3 Running Pipetting Program

All steps that will be performed are checked. If you want to skip steps during a pipetting run, you can uncheck a Group Command to skip all steps in that group, or uncheck an individual step.



The following screen shows all the steps used in this program.



4.3.2 Sample Serial Dilution Program

In this sample program, liquid is aspirated from a deep well block and dispensed into a 384-well microplate:

Tip magazines specifically designed for serial dilutions are available:



Figure 4-6: 96-ch. Serial Dilution Magazine



Figure 4-7: 384-ch. Serial Dilution Magazine

The tip magazines above are for portrait orientation (for row-wise access). Other configurations are also available:

Catalog No.	Orientation	Pipettor Head Type	D.A.R.T.s Tips
301-30020	Portrait	501-20001	5516, 5517, 5518 or 5536, 5537, 5538
301-30021	Portrait	501-20004	5506, 5507, 5508 or 5501, 5502
301-30022	Portrait	501-20002	5316, 5317, 5318, 5416, 5417, 5418 or 5326, 5327, 5528
501-30020	Landscape	501-20001	5516, 5517, 5518 or 5536, 5537, 5538
501-30021	Landscape	501-20004	5506, 5507, 5508 or 5501, 5502
500-10015	Landscape	501-20002	5301, 5302
500-10020	Landscape	501-20002	5311, 5312
500-10025	Landscape	501-20005	5321, 5322
500-10030	Landscape	501-20002 or 501-20005	5316, 5317, 5318, 5416, 5417, 5418 or 5326, 5327, 5528

4.3 Running Pipetting Program

The following screen shows the steps for a serial dilution program:

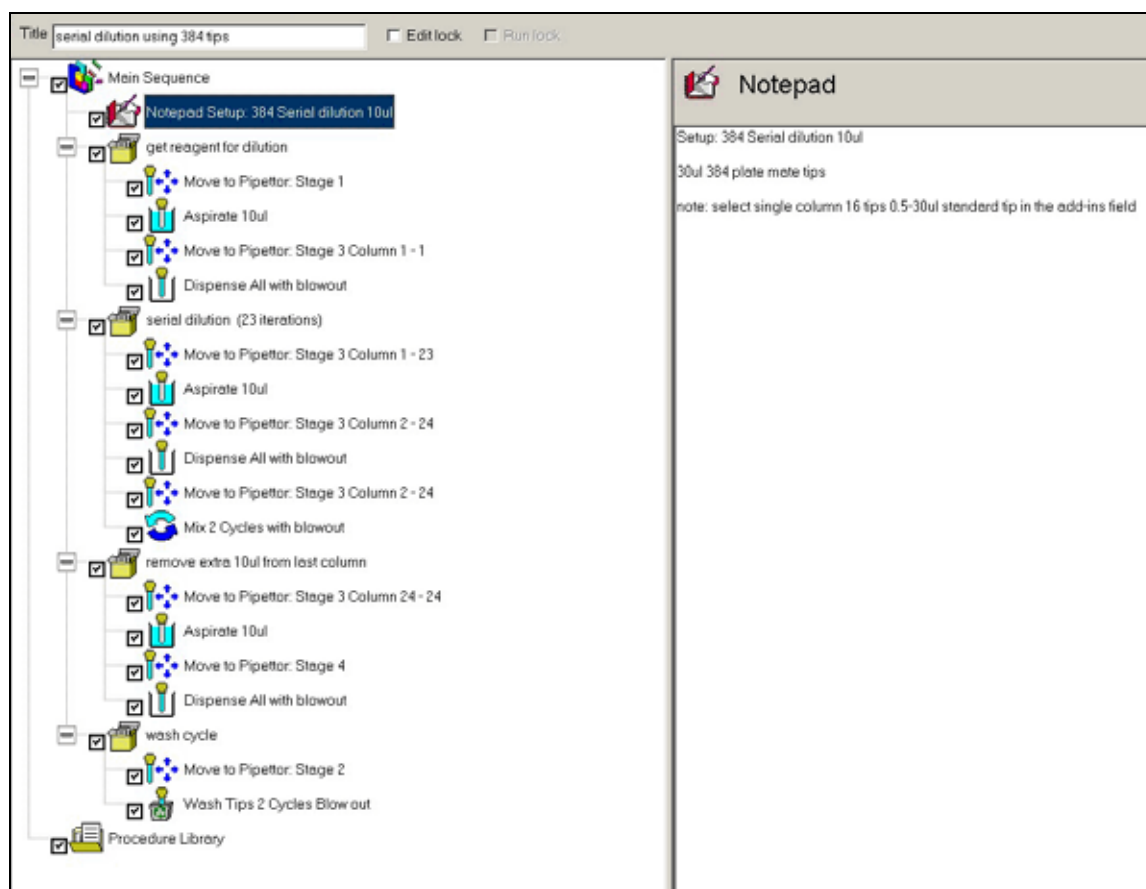


Figure 4-8: ControlMate Program for Serial Dilution

For this example, use the following guidelines:

- Select pipettor configuration for single row tips
- Change tips to single-row or two-row SD tip magazine.
- Specify **start** and **end** column in **Move** command.
- Place Reagent plate in stage position 1.
- Place Tip Wash in stage position 2.
- Place Dilution plate in stage position 3.
- Place 384-channel Reservoir in stage position 4.

Stage 1: Reagent Plate	Stage 2: Tip Wash
Stage 3: Dilution Plate	Stage 4: 384-ch Reservoir
Stage 5: Dilution Plate	Stage 6: Dilution Plate

4.4 Shutting Down

When you are ready to shut down the **Thermo Scientific Matrix PlateMate 2x3**, refer to the following checklist:

- ❑ **Change pipettor head or pipet tips.** Change the pipettor head if you will be using different sized pipet tips next time. Remove used tips and insert new tips for use next time.
- ❑ **Remove buffers or reagents.** Remove the buffers or reagents that you have used. Use the Pump procedure to empty buffer or reagents from the tubing to their source containers. Flush the tubing with distilled water, if necessary.
- ❑ **Remove microplates.** Remove any coated microplates or v-bottom reservoirs, if necessary.
- ❑ **Shut down ControlMate.** Save any programs, if you made changes, and shut down the **ControlMate** software. Shut down the PC if you will not be using it.
- ❑ **Shut down Thermo Scientific Matrix PlateMate 2x3 instrument.** After all necessary plates and ancillaries have been removed, press the on/off switch to power down the instrument and shut it off.
- ❑ **Clean any liquid spills as needed.**

5 Alternate Computer Options

5.1 External Keypad

The external keypad provides basic functionality to the **Thermo Scientific Matrix PlateMate 2x3**. It is used primarily for troubleshooting.

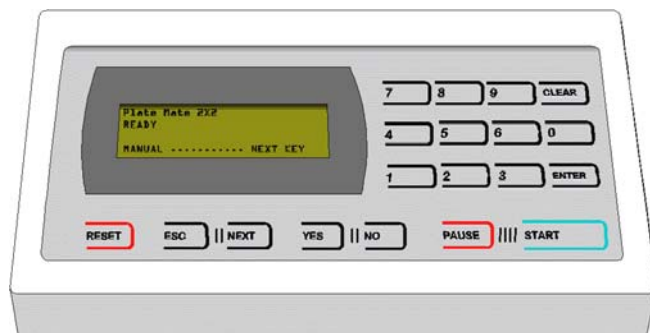
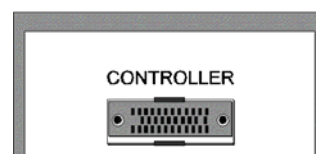


Figure 21: External Keypad

For instrument operation, refer to the following instructions:

1. Connect the Keypad cable to the Controller port on the side of the instrument.
2. Turn on the Keypad.



```
PlateMate  2x3
READY
MANUAL ..... NEXT KEY
```

The READY screen appears.

3. Press the “NEXT” key to enable manual movement of the **Thermo Scientific Matrix PlateMate 2x3**.

The screen shows the current axis positions of the moveable components of the Thermo Scientific Matrix PlateMate 2x3.

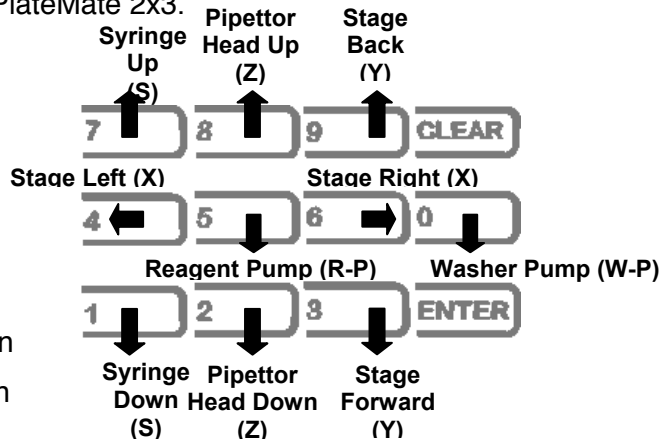
```
MANUAL
X..46  Y..93  Z..82
S..71  R P.5  W P.0
ESC or RESET Key
```

X, Y, Z = Stage position

S = Syringe position

R_P = Reagent Pump position

W_P = Washer Pump position



4. Use the numeric keypad to move each component.

Call your Matrix representative for additional information on the external keypad.

5.2 PC Command-line (Host PC Communications)

Thermo Scientific Matrix PlateMate 2x3 can be PC-controlled using commands from the command-line instead of the **ControlMate** software. Command-line control includes stage movements, stacker sensors, and barcode communication.

The following communication settings are required:

- 9600 bps
- Stop bits: 1
- Parity: Even
- Flow control: None
- Data bits: 7
- All ASCII

Refer to *Appendix A, Host PC Communications*, for more detailed specifications, a listing of control commands, and instructions on their use.

5.3 ControlMate OLE

5.3.1 Introduction

ControlMate provides an application developer with an ActiveX COM automation interface for the **ControlMate** device control application. The component will enable an application to initiate an object that can load, modify, and execute **ControlMate** Sequence files.

The calls made to the **ControlMate** components do not involve the need to load the **ControlMate** application in memory.

A very powerful and useful feature of the **ControlMate** OLE component is the ability to dynamically change and set command field values within a sequence file. This allows the external integration of information such as source values (for example, aspiration volumes) to be extrapolated from databases.

5.3.2 Build and Distribution

The **ControlMate** OLE component can be distributed as a required component within the client application. Any component dependencies will be included as part of the application build.

5.3.3 Development Environment

The **ControlMate** OLE component has been developed for use with Microsoft® Visual Basic® versions 5 and 6.

For more information about how to use this option, refer to the *ControlMate OLE User Manual*.

6 Pipetting Techniques

This chapter discusses pipetting techniques that can be used to optimize pipetting precision for small volumes and to calibrate for different liquid densities.

6.1 Optimizing Pipetting Performance

Precision and accuracy can be difficult to obtain when pipetting small liquid volumes, such as 1.0 μL or 0.5 μL . This section describes the dispense procedure that was used to test the **Thermo Scientific Matrix PlateMate 2x3** for small volumes and discusses the critical parameters that affect pipetting performance.

6.1.1 Dry Plate Dispense Procedure

This procedure documents the techniques that were used to optimize **Thermo Scientific Matrix PlateMate 2x3** dispense capabilities for dry plate dispensing of 0.5 to 1.0 μL . It also provides the actual programming conditions under which optimum precision can be obtained by using 12.5 μL and 30.0 μL pipet tips for 384 well plates, and 12.5 μL pipet tips for 1536 well plates.

Materials and Methods

All data and results included in this procedure were obtained using the following materials:

Thermo Scientific Matrix PlateMate 2x3 Base Unit (Cat No. 501-1-10001)
384/30 μL Pipetting Head (Catalog No. 501-20002)
384/30 μL Tips (Catalog No. 5311)
384/12.5 μL Tips (Catalog No. 5301)
Matrix 384 Flat bottom Plates (Catalog No. 4318)
Matrix 1536 Plates (Catalog No. 4512B)
Tecan Ultra Microplate Reader
ControlMate for **Thermo Scientific Matrix PlateMate 2x3**
WellMate dispenser

A 384-channel head was used to pipet 1.0 μL and 0.5 μL Rhodamine Green (R110) fluorescent dye into pre-weighed 384 well plates. The plates were weighed again before adding 100 μL of PBS (Phosphate Buffered Saline) to each well with a calibrated Multidrop (CV: 1.8% at 100 μL). The 384 well plates were then read using a Tecan Ultra that uses an excitation $\lambda=485$ nm, emission $\lambda=535$ nm, with 3 flashes per well.

The following table summarizes the precision results that were obtained:

Table 6-1: Precision Results With 12.5 μL Pipet Tips

DISPENSE VOLUME	PRECISION (C.V.%)*
1.0 μL	< 2.0%
0.5 μL	< 3.0%

*Mean for 3 plates

Software programming

The following **ControlMate** programs were written for 0.5 μL and 1.0 μL dry dispensing into 384 and 1536 well plates.

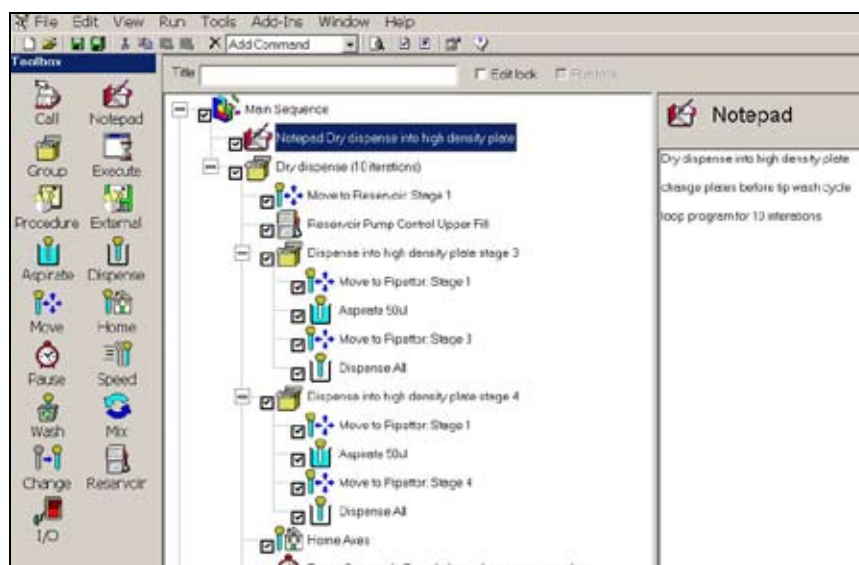


Figure 6-1: Dry Dispense using 0.5 mL

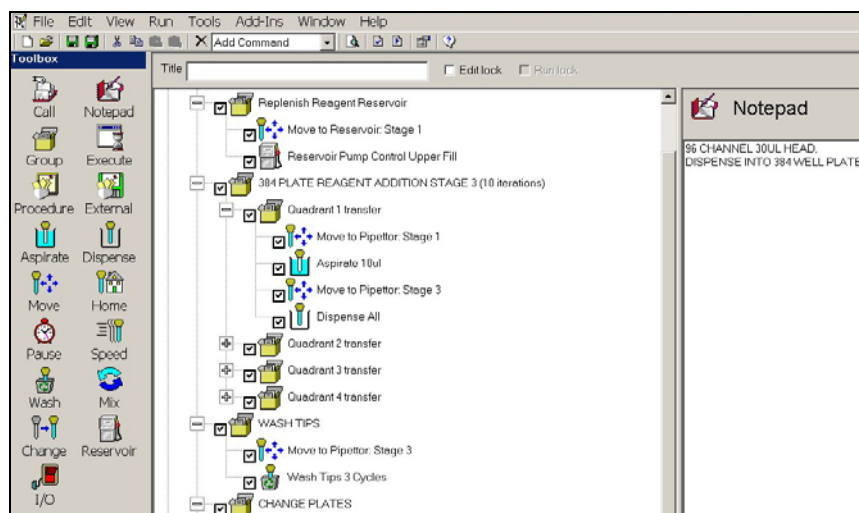


Figure 6-2: Dry Dispense using 1.0 mL

Pipetting Techniques for Small Volumes

The dispense procedure resulted in the following techniques to optimize pipetting precision for small dispense volumes of fluorescence into dry 384 and 1536 well plates.

Critical parameters affecting performance included: **Pipetting speed** (slower is better for small volumes), **Plate height** (tip should be 0.1-0.3 mm above the well bottom) and **Dwell times** at the dispense step. Slower pipetting speed prevented droplets that formed at the ends of the tips from contacting the sides or top of the wells as the plate was raised. Optimal plate height ensured that the droplets made contact with the well bottom and were removed from the tip during the dispense step. Longer dwell times allowed liquid drop formation at the end of the pipet tip.

Piston Speed: Slow piston speed is recommended for small volume aspiration and dispensing.

Plate Height: Plate height requires some trial and error to determine the optimal distance from the well bottom. A height that places the tips too deep in the wells will seal the tip to the well bottom and not allow the liquid to leave the tip. If the tips are not deep enough, the dispensed droplet will not make contact with the well bottom and will not remove the droplet from the tip (see the following diagrams).

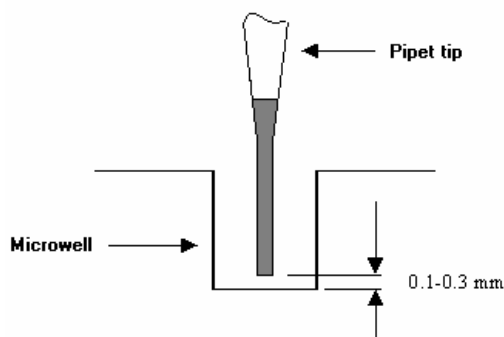


Figure 6-3: Position of the tip in the plate before dispense

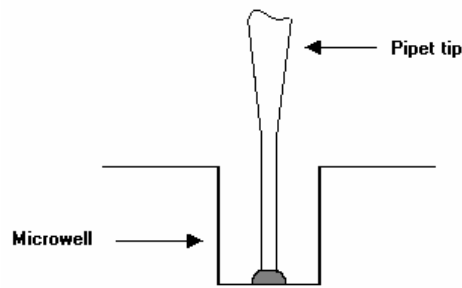


Figure 6-4: Position of the pipet tip during dispense of liquid and air blowout

When positioning the plate under the tips for a small volume dispense, allow approximately 0.1-0.3mm of space above the well bottom prior to executing the dispense step to allow the droplet to contact the bottom of the well.

Dwell Time: During the dispense step for a small volume it is important to use a Dwell Time to allow the volume droplet to form on the end of the pipet tip. As a general rule dwell times are dependant on the dispense volume and liquid type. Smaller dispense volumes require longer dwell times. (e.g., 0.5 – 1.0 μL dwell times should be 1.5-2.0 seconds).

Blowout: Do not use 'Dispense All with a Blowout'! Use a specific dispense volume. Instead of using the blowout command, aspirate a small volume of air before aspirating the desired quantity of liquid. Using this aspirated air as the blowout allows the Dwell Time to be executed near the bottom of the well, not above the well where a pause after a blowout takes place (usually a pause after a blowout is not required). The extra air volume should be great enough to overcome any capillary action in the small tip orifice. The air volume should be sufficient to assist the separation of the droplet from the tip to the well bottom, but not so great that air bubbles become a problem. The air blowout is another parameter that is often optimized by trial and error.

6.2 Calibrating for Different Liquids

(Improving pipetting accuracy)

Thermo Scientific Matrix PlateMate 2x3 is factory calibrated for distilled water at room temperature; however, you can add calibration values to improve pipetting accuracy of liquids with specific gravity that is significantly different from water.

6.2.1 Introduction

The calibration feature defines the number of steps that the piston motor uses to raise or lower the pipetting pistons during a pipetting cycle. A liquid type with high viscosity requires more time to move through the pipet tip. By increasing or decreasing the number of motor steps, the pistons aspirate and dispense more or less liquid dependent on that liquid's characteristics (specific gravity). Liquids exhibiting higher specific gravity than water require fewer motor steps and liquids exhibiting lower specific gravity than that of water will require more motor steps.

Through **ControlMate**, you can define and save calibration values for a library of liquid types. These settings will be available as choices when you insert an aspirate or dispense command.

The calibration procedure is performed by obtaining five volumetric weights using **ControlMate** to run a dispense program. The weights, as well as the liquid's conversion factor, are entered in the **ControlMate** Volumetric Calculation program. **ControlMate** converts the weights to volume, averages the results, and calculates the motor steps factor.

This feature is also useful to determine if you need to define calibration values for a specific liquid. After obtaining the volumetric weights, you can compare the weights to the **Thermo Scientific Matrix PlateMate 2x3** accuracy specifications. If the results are outside of the accuracy specification, then continue with the rest of the procedure to calculate the motor steps factor.

6.2.2 Calibration Procedure

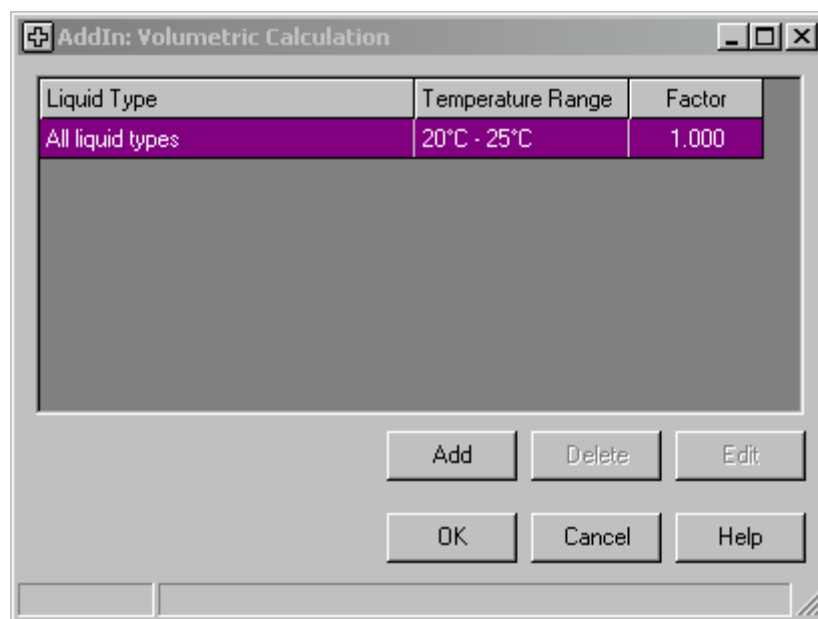
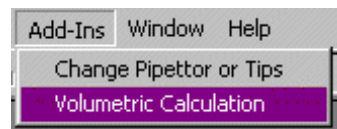
Use the following procedure to calibrate **Thermo Scientific Matrix PlateMate 2x3** for different liquids:

1. Create a **ControlMate** dispense program for 96-well or 384-well microplate.
2. Weigh a dry microplate using a gravimetric balance.
3. Use the distilled water setting (motor factor 1.000) to dispense a specified volume of the target liquid (e.g., 10 μ L).

Note: Since **Thermo Scientific Matrix PlateMate 2x3** is calibrated to distilled water, it uses a motor factor setting of 1.000).

4. Dispense the liquid into the microplate.
5. Weigh the filled microplate and calculate the final weight of the liquid in a single microwell.
6. Repeat the weighing and dispensing steps to obtain five weights.
7. Start **ControlMate** to use the Volumetric Calculation program. From the Tools Menu, click “Add-Ins”, then “Volumetric Calculation”.

The following window opens.



The first liquid type, which was used in Step 2, is the calibration value for distilled water at room temperature. **Thermo Scientific Matrix PlateMate 2x3** is configured to set this value to 1.000.

8. Click “Add” to create another liquid type.

Chapter 6 Pipetting Techniques

9. Name the liquid type and calibration temperature.

Sample	Weight (mg)	Volume (ul)
1		
2		

10. Enter the correct conversion factor for the liquid (e.g. 1.123). The conversion factor will be used to convert the weight to volume.
11. Enter the five gravimetric weights obtained in step 5.

Sample	Weight (mg)	Volume (ul)
1	11.3	12.69
2	11	12.35
3	11.5	12.91
4	11.1	12.47
5	11.3	12.69
Average	11.24	12.62

Motor steps factor: 0.792

Buttons: Update, Cancel Edit, OK, Cancel, Help

The volume calculation, average values, and motor steps factor are automatically generated.

12. Click “Update”

The motor steps factor for the liquid type is saved in **ControlMate** and used when you select this liquid type for an aspiration or dispense step.

Aspirate

Volumetric: All liquid types @ 20 - 25 Celsius

Overstroke: Plasma @ 20 - 25 Celsius

7 Maintenance and Service



WARNING! Do not disassemble or modify the components of the *Thermo Scientific Matrix PlateMate 2x3*, except as specified in this manual. Only Thermo Fisher Scientific service personnel are authorized to perform any additional service to the instrument.

7.1 Maintenance

7.1.1 Regular Inspections

Perform the following tasks before running the *Thermo Scientific Matrix PlateMate 2x3* as indicated below:

Item	Cycle	Action
Container type	Before start	Confirm proper containers are set on correct position areas.
Setting containers	Before start	Ensure proper reagent and amounts are in correct reservoirs.
Warm-up	At start	Perform operation without containers in position areas.
Verify movement accuracy	Once weekly	Operate with empty containers and confirm that the tip enters properly into the mouth of each container. If not, factory values need to be reset or adjusted. Contact Thermo Fisher Scientific Service Department.
Leak test	Once weekly	After aspirating liquid, pause the instrument and confirm the liquid level in the tips. Allow the Thermo Scientific Matrix PlateMate 2x3 to sit paused for approximately 5 minutes, then observe the level in the tips again to ensure that there is no leak. Problems are caused by wear on the nozzle, piston, O-rings and seal rings. Contact Thermo Fisher Scientific Service Department, if a leak is observed.

7.1.2 Periodic Inspections

- Inspect tubing and power cord periodically for frayed or worn spots or tears. Replace damaged tubing or power cord before using the instrument. See *Section 7.2.1* to replace tubing.
- Inspect the tubing in the peristaltic pump periodically during a pipetting run. If the tubing appears to be slipping in either direction, adjust the tension levers on both sides of the peristaltic pump. Ensure that the tubing is not stretched over the pipettor hood or being pulled out of the sensor bracket.

7.1.3 Cleaning



WARNING! Never plug, unplug, or otherwise touch the power cord when your hands are wet. Contact with the cord can cause severe shock hazard.

CAUTION! Always turn off the power and unplug the power transformer before cleaning the instrument. Fluid seepage can damage internal components.

- Clean the exterior of the instrument as needed with a mild detergent.

CAUTION! Do not clean the instrument with abrasive cleansers, flammable or caustic solutions, or solvents (such as paint thinners or acetone). Use of such cleansers will damage the instrument housing, keyboard, and display.

- If a liquid is spilled during use, wipe it up immediately. If the instrument is operating, stop the operation, turn off and unplug the instrument, then wipe the liquid before continuing.

7.1.4 Storage

If the instrument will not be used for a period of time, do the following:

- Remove any remaining liquid from the tubing.
- Remove used tips.
- Unplug and clean the instrument.

After storage, and prior to using the instrument, do the following:

- Inspect the power cord for frayed or worn spots or tears and clean off any dust or dirt on the power plug.
- Inspect the instrument thoroughly for broken or loose components.
- Perform general maintenance and cleaning procedures.

Prior to using the instrument after extended storage, have it inspected by a Thermo Fisher Scientific service engineer.

7.2 Service



WARNING! Always turn off the power switch and unplug the power cord when servicing the device. Contact with internal components or other components connected to the line power can cause severe shock hazard. Perform only service procedures that are described in the manual or authorized by Thermo Fisher Scientific Service Department service personnel.

7.2.1 Replacing Tubing

The **Thermo Scientific Matrix PlateMate 2x3** is designed with Easy-Load[®] peristaltic pumps and quick-disconnect fittings to easily replace Reagent tubing, Tip Wash Inlet and Waste Outlet lines.

The **Thermo Scientific Matrix PlateMate 2x3** uses two basic fluid systems:

- Reagent fill
- Tip Wash

The sections that follow describe tubing replacement for each fluid system.

Reagent Fill

Two reagent filling nozzles are available to fill plates on both sides of the microplate deck (if the Tip Wash Station is not used). In the following diagram, Reagent 1 flows through the upper peristaltic pump and filling nozzle in the left sensor bracket to stage position 1; Reagent 2 flows through the lower peristaltic pump and filling nozzle in the right sensor bracket to stage position 2.

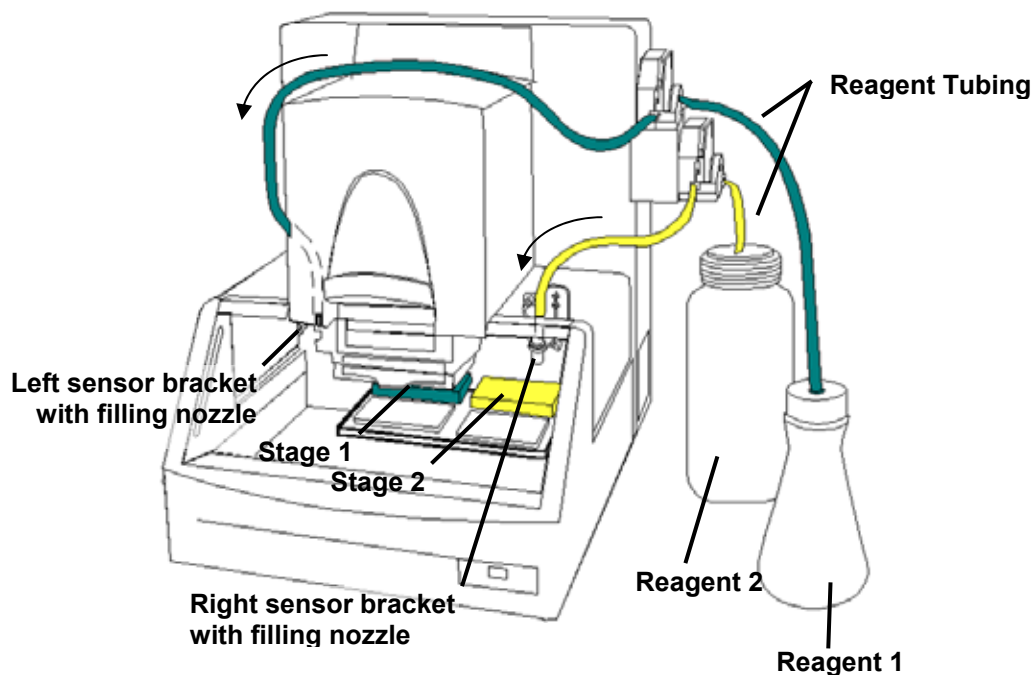


Figure 7-1: Reagent Reservoir Fluid Lines

Both reagent tubing and filling nozzle can be replaced with the tubing kit included with the **Thermo Scientific Matrix PlateMate 2x3** system. If additional tubing kits are needed, contact Thermo Fisher Scientific Service Department to order Part No.# 301-30030. Tubing set includes tubing, filling nozzle, and weight.

To replace Reagent tubing:

1. Remove used tubing.
 - a. Flush remaining fluid from the tubing back into the reagent reservoir by reversing the pump flow (see Reservoir Pump Control in Help).
 - b. Turn the pump lever to the left to release the tubing.

7.2 Service

- c. Loosen the adjustment screw to release the filling nozzle and tubing.

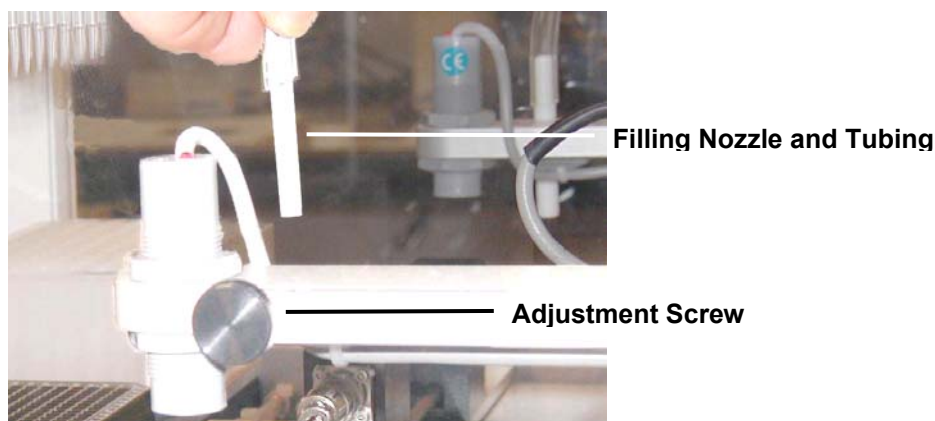


Figure 7-2: Replacing Filling Nozzle and Tubing

- d. Remove and properly dispose of the used tubing.
2. Select replacement tubing that is approved for use with the **Thermo Scientific Matrix PlateMate 2x3** system.
 3. Insert the new filling nozzle into the sensor bracket and tighten the adjustment screw to secure the filling nozzle.
 4. Drape the tubing over the pipettor hood for the left sensor bracket (see Figure 7-1: Reagent Reservoir Fluid Lines), or allow for sufficient slack for the right sensor bracket to prevent pulling or straining of the tubing during pump operation.
 5. Thread the new tubing through the peristaltic pump, pressing it firmly between the rollers in the pump, then turn the pump lever to the right to secure the tubing.



Figure 7-3: Installing Tubing in Upper Peristaltic Pump

6. Adjust the tension levers on both sides of the pump to prevent the tubing from slipping while the pump is in operation. You may need to observe the tubing during pump operation to ensure that the tubing is secure.

Chapter 7 Maintenance and Service

7. Insert the free end of the tubing into the reagent reservoir.
8. Repeat this procedure to replace the second reagent tubing, if it is needed.

The new reagent tubing is ready to use.

Tip Wash Tubing

When the Tip Wash Station is used, it occupies stage position 2 (see following diagram) and requires the lower peristaltic pump; therefore, only one reagent solution can be used in stage position 1.

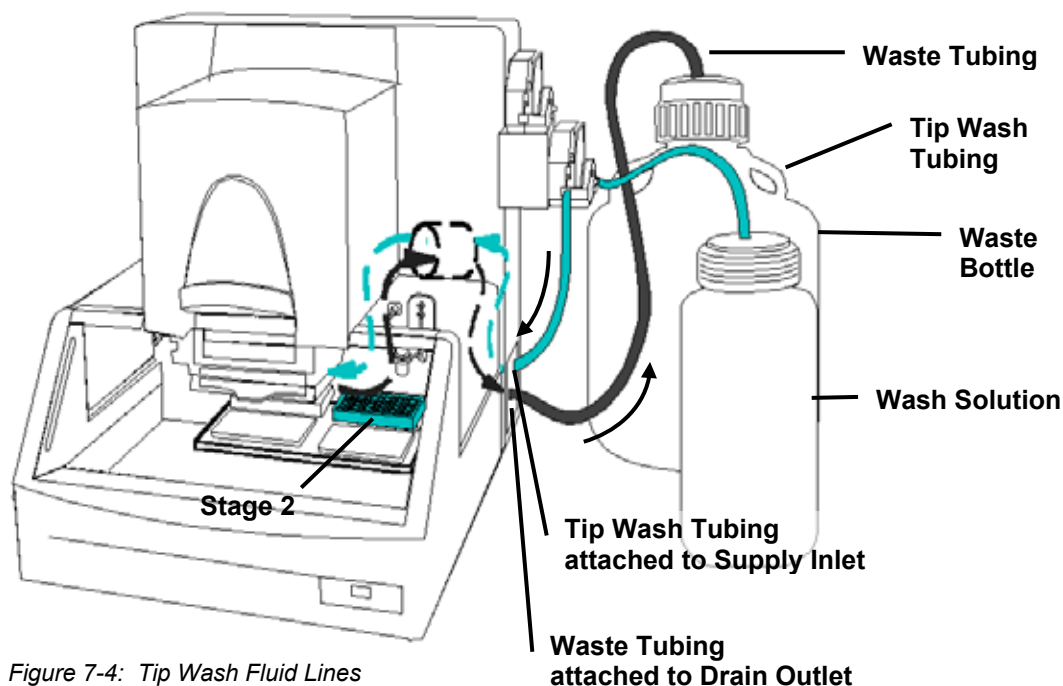
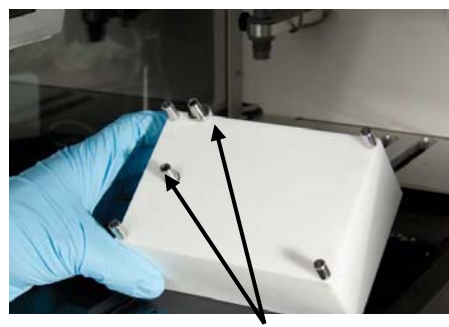
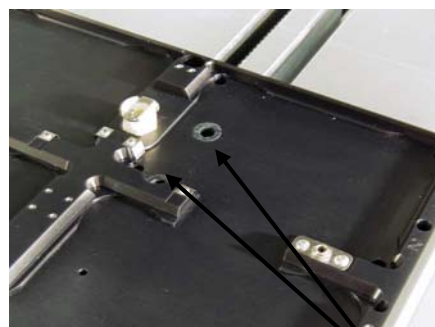


Figure 7-4: Tip Wash Fluid Lines

The Tip Wash Station uses two external tubing that connect the wash solution and waste bottle to the instrument through the Supply Inlet and Drain outlet, as shown in the previous diagram.

The Tip Wash Station also uses internal tubing located in the platform stage (see following photo). The internal tubing is located on the underside of the tip wash station and can be replaced with a new Tip Wash Station. Any other internal tubing should be replaced by authorized Thermo Fisher Scientific service personnel.



Internal tubing outlets on platform stage

Input/ Outlet ports on tip wash station

Figure 7-5: Tip Wash Fluid Lines on platform and tip wash station

To replace external tubing:

1. Remove used tubing.
 - a. Flush remaining fluid from the tubing back into the Tip Wash reservoir. (Use the Reservoir Pump Control command and select Empty for approximately 20 seconds to remove all residual fluid from the system).
 - b. Turn the pump lever to the left to release the tubing for the Wash Solution.
 - c. Remove and properly dispose of the used tubing.
2. Select replacement tubing that is approved for use with the **Thermo Scientific Matrix PlateMate 2x3** system.
3. Insert the new tubing into the Supply Inlet on the side of the instrument.



4. Allow for sufficient slack to prevent pulling or straining of the tubing during pump operation.
5. Thread the new tubing through the **lower** peristaltic pump, pressing it firmly between the rollers in the pump, then turn the pump lever to the right to secure the tubing.
6. Adjust the tension levers on both sides of the pump to prevent the tubing from slipping while the pump is in operation. You may need to observe the tubing during pump operation to ensure that the tubing is secure.



Figure 7-6: Installing Tubing in Lower Peristaltic Pump

7.2 Service

7. Insert the free end of the tubing into the Tip Wash solution.
8. Insert the new tubing for the Waste liquid into the Drain on the side of the instrument.



Drain Outlet

9. Insert the free end of the tubing into the Waste Bottle.

The new Tip Wash tubing is ready to use.

8 Troubleshooting

8.1 Mechanical

Problem	Cause	Action Required
Reagent reservoir overfills	Liquid level sensor is not functioning.	- Adjust liquid level sensor (see Section 4.2.3, <i>Onboard Reagent Filling</i>). - Contact Thermo Fisher Scientific Service Department.
Tip wash station overfills	Liquid level sensor is not plugged into the connector.	Reconnect the sensor wire.
Tubing in peristaltic pump slips.	- Peristaltic pump not adjusted for tubing. - Incorrect tubing was used.	- Adjust side forks on peristaltic pump. See Section 7.2.1, <i>Replacing Fluid Lines</i>. - Replace with tubing recommended for Thermo Scientific PlateMate 2x3.
Peristaltic pump is stalled or burned out.	Wrong tubing was used.	- Replace with tubing recommended for Thermo Scientific PlateMate 2x3. - Contact Thermo Fisher Scientific Service Department for repair or replacement of the pump motor.
Tips crash into microplate	- Pistons need to be calibrated. - Mismatch of tips to plate type. - Mismatch of D.A.R.T. tips to pipetting head.	- Recalibrate pistons. See Section 4.2.7, <i>Platform Calibration Procedure</i>. - Redefine plate type. See Section 4.2.6, <i>Defining New Plate Types</i>. - Correct settings for pipetting head or tips in AddIn->Select Pipettor or Tips command.
Thermo Scientific Matrix PlateMate 2x3 does not power on.	- Power cable loose or disconnected. - Blown fuse	- Check connection to the wall outlet. - Contact Thermo Fisher Scientific Service Department.

8.2 Error Messages

Error Messages	Cause	Action Required
X axis error, Y axis error	- Platform stage movement impeded by obstruction. - Axis address value for stage configuration is too large.	- Check for obstruction to vessels on platform stages. - Check for obstruction to platform stage tracks. - Check platform stage settings.
Stage 1 Z axis error, Stage 2 Z axis error, Stage 3 Z axis error, Stage 4 Z axis error Stage 5 Z axis error Stage 6 Z axis error	- Pipettor head movement impeded by obstruction. - Pipettor tips crash into vessel.	- Check for obstructions to pipettor head or vertical track. - Check for the correct combination of pipettor head, tips, and vessel type.
Syringe motor error	Pistons in pipettor head obstructed or moved out of its physical range.	- Check for obstructions in piston shafts. - Check piston settings in Add-in->Change Pipettor or Tips screen.
Unable to read barcode Unable to communicate with the barcode reader.	- Barcode label is covered or damaged. - Barcode reader is not connected.	- Check for obstruction or damaged barcode vessel. - Check for loose or faulty cable connections.
Command transmission error	- Device receives command it does not recognize. - Command timeout is set too low.	- Check for faulty data cable. - Increase command timeout setting.
ACK timeout	Instrument does not respond to ControlMate commands.	Check that the cables are correctly connected and that the power is switched on and available.
Command timeout	- Device begins or performs an action, but does not respond to software. - Timeout is set too low.	- Check PC connection to device. - Increase timeout setting.

Error Messages	Cause	Action Required
Z axis obstruction safety mechanism activated	- Pipettor head housing door opened during pipettor or piston head movement. - Light curtain detects motion or obstruction during pipettor or piston head movements.	- Close housing door to resume action. - Remove hand or other obstruction from the pipetting area before resuming action.
The device has not been configured.	User attempts to run sequence file before completing pipettor or tip configuration.	Configure pipettor and tips in Add-in->Change Pipettor or Tips screen.
Unable to establish communication with the device.	Device does not respond when user presses Start to begin sequence file.	- Verify that the tip magazine is in place and properly seated behind the stop tabs in the clamping frame. ControlMate will not allow a program to run unless the tip magazine is in place. - Check that the cables are correctly connected and that the power is switched on and available. - Check communication port in Tools->Options->Connection screen.
Press OK to resume or Cancel to abort the run execution.	User presses Stop button during sequence file run.	Follow directions in the error message.
Please ensure that a tip magazine is loaded	Tip magazine is not detected during the initialization of a sequence file.	- Insert a tip magazine. - If a tip magazine is present, ensure that it is properly seated behind the stop tabs in the clamping frame. - Check the limit switch that detects the tip magazine; replace if it is defective.

A.1 Hardware Specifications

- (2)
- | G | | G |
|-----|--|-----|
| TXD | | TXD |
| RXD | | RXD |
| DTR | | DTR |
| DSR | | DSR |
| CTS | | CTS |
| RTS | | RTS |

- | | | |
|------------|-------|------------------|
| SXT | ##### | EXT |
| SXT (02H): | | Start of message |
| EXT (03H): | | End of message |

(4) Transmission Protocol

- a. Transmit $\longrightarrow$ Correct receive
 $\longleftarrow$ ACK
- b. Transmit $\longrightarrow$ Incorrect receive
 No response

Re-transmit → Correct receive
 ← ACK

- c. Transmission error with repeated “no response” is to be judged by the transmitting side.
- d. PC does not return “ACK” against “R” transmission from **Thermo Scientific Matrix PlateMate 2x3**

- a. Positive Response STX ACK ETX
 ACK (06H)

A.1.1 Basic Message Specification

(1) STX + Discrimination + DATA + ETX

A.2 Control Commands

A.2.1 PC → Thermo Scientific Matrix PlateMate 2x3

1.	0	Opening COM port. You can find the information about the version of the last page .
2.	R	Reset for all axis. After the initialization is done, “R” is sent.
	R####	Reset for the specified axis. Numbers are shown for each axis, X, Y, Z, S. This command will initialize only the axis for the value you enter.
3.	SX Y	Both X and Y axis will move to the point where you address at the same time.
4.	X	Move on X axis
5.	Y	Move on Y axis
5.	XS	Setting Speed on X axis
		XS1030 – 1255
7.	YS	Setting Speed on Y axis
		YS1030 – 1255
8.	Z	Move on Z axis
9.	ZS	Setting Speed on Z axis
		XS1030 – 1255
10.	S	Move on S axis
11.	SS	Setting Speed on S axis same as Thermo Scientific Matrix PlateMate 2x3
12.	M10	Upper comp (External Piping), OFF
13.	M11	Upper Pump (External Piping, ON (Supply))
14.	M12	Upper Pump (External Piping), ON (Drain)
15.	M1S	Setting Speed on M1*, 1010 – 1050
		* M1 pump is not available with the other axes at the same time due to the relation to the hardware.
16.	M20	Lower Pump (Internal Piping), OFF
17.	M21	Lower Pump (Internal Piping), ON (Supply)

18.	M22	Lower Pump (Internal Piping). ON (Drain)
19	M2S	Setting Speed on M2, 1010 – 1050
20.	M30	Drain Pump, OFF
21.	M31	Drain Pump, ON
22.	D10	DC Output (right), OFF
23.	D11	DC Output (right), ON
24.	D20	DC Output (left), OFF
25.	D21	DC Output (left), ON
26.	QX	Show X axis address
27.	QY	Show Y axis address
28.	QZ	Show Z axis address
29.	QS	Show S axis address
30	QM	Checking S axis lower sensor
31.	QT	Checking tip magazine
32.	QF1	Checking Right side Liquid Sensor
33.	QF2	Checking the left side of Liquid Sensor
34.	QW	Checking Wash Station sensor
35.	W	Setting Delay Time, 001 – 250(10mS – 2,500mS)
36.	P	Pause all axis
37.	A	Restart
38.	I	I Command
39.	BO	Operate without Barcode Reader
40.	B1	Operate with Barcode Reader
41.	BR	Read Barcode

The Teaching commands

Stages:

1	2
3	4
5	6

The center position of each stage will be changed depending on which type of plate you use; therefore, you need to redo “teaching” and enter new value each time you use a different type of plate.

1.	TXO	Move 0.1mm to right on X axis
3.	TX1	Move 0.1mm to left on X axis
4.	TYO	Move 0.1mm forward on Y axis
5.	TYI	Move 0.1mm backward on Y axis
6.	TZO	Move 0.1mm downward on Z axis
7.	TZI	Move 0.1mm upward on Z axis

These are the commands required for “teaching”. Obtain the address by using QX, QY, and QZ.

Both X and Y Move commands can be used at the same time.

A.2.2 Thermo Scientific Matrix PlateMate 2x3 → PC

1.	OK	All tasks are completed without fail
3.	X	X axis coordination
4.	Y	Y axis coordination
5.	Z	Z axis coordination
6.	S	S axis coordination
7.	P	Each axis stop after receiving “P”
8.	M0	S axis Lower Sensor, OFF
9.	M1	S axis Lower Sensor, ON
10.	T0	No tip magazine installed
11.	T1	Tip magazine installed
12.	FIO	Right liquid sensor, OFF

13.	FI1	Right liquid sensor, ON
14.	F20	Left liquid sensor, OFF
15.	F21	Left liquid sensor, ON
16.	W0	Wash station sensor , OFF
17.	W1	Wash station sensor, ON
18.	BD	Transmitting barcode data
19.	Error Messages:	
	E01	Error related to X axis
	E02	Error related to Y axis
	E03	Error related to Z axis
	E04	Error related to S axis
	E10	Communication problem with Barcode Reader
	E11	Fail to read Barcode
	E98	Stop caused by Light curtain, ON
	E9	Command Error

Amount of movement on each axis:

X : 0.05mm/1 address

Y : 0.05mm/1 address

Z : 0.005mm/1 address

S : Same as **Thermo Scientific Matrix PlateMate 2x3**

Other commands: Version, Pause Reset

a) Version information

STX O ETX

STX ACK ETX

STX 1.01, F10, F20, W0, M0, T0 ETX

STX ACK ETX

STX OK ETX

STX ACK ETX

b) Pause Reset:

STX P ETX

STX ACK ETX

STX P ETX

STX ACK ETX

Sending "Reset" individually:

STX R ETX

STX ACK ETX

Note: “R####” command is not available in “Reset” command after “Pause”.

Barcode Communication

1. Connect the bar code reader to COM2.
2. The power supply for the bar code reader is supplied from the COM2 port and the DC motor revolves when the machine is turned on. Under these conditions, even if the reader is not used, the motor revolves and the life of the bar code reader is shortened. When the reader is not used, transmit “B0” so that it stops.
3. Transmit the following telegram for bar code reading. This is an example of how it looks when reading the ZD code:

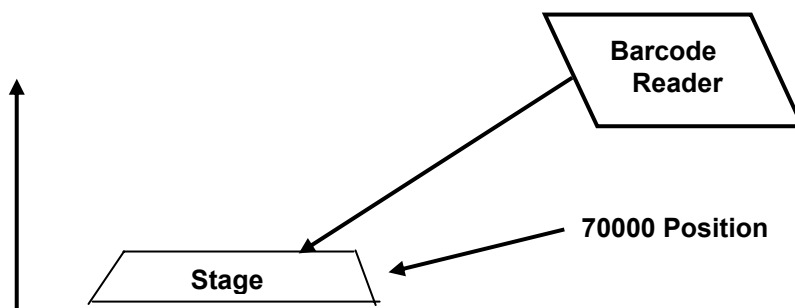
***X8BRZD ***ETX ETX : Telegram ends.

By X8, stage ZD moves under the head.

By BR, the bar code reader laser turns on.

By ZD****, ZD reads the bar code when it moves to **** address, after moving to the address, transmit the data to the PC.

After receiving the data, transmit the following operation:



Align the laser as shown above, so that it reads the data as the stage moves up.

4. The bar code reader is generally used with the default value. Only cord types can be changed. Use carefully to avoid changing the setup.
5. “E11” is transmitted when the bar code reading fail; therefore, transmit the read error ID.
6. If the X axis slips, transmit “E01” and wait for “A” or “R.”
When receiving “A,” the X axis returns to home position again and continues.

B *ControlMate* 'Rules' Definitions

B.1 Introduction

ControlMate uses external configurable rules architecture to provide field bounds and sequential sequence checking. This method provides the maximum flexibility by which field and program sequencing validation can be achieved and facilitates the building of a good degree of accuracy and device resilience.

The rule parameters are totally configurable and can be increased or reduced for each installation. The rules engine is generic and is therefore not dependent to a specific device module. However it is possible to create specific rules for a particular device.

Note: This architecture allows the minimum amount of support in rule creation by applying a generic architecture yet allows the maximum flexibility in device control.

The rules parameters are contained within the module INI file (e.g., *PlateMate2x3.ini*).

Rules are declared as one of two types:

- **Field Bounds Checking**
These are created to validate the minimum and maximum values of specific fields
- **Sequential Sequence Checking**
These exist to validate the relationship between commands within a programmed sequence.

Note: Once a file has passed validation, it can be used to control a device. Unless a command is changed (added, deleted, moved or a field amended), it does not need further validation. This reduces start up time when issuing the sequence to the device.

B.2 Field Bounds Checking

These rules are known as 'LIMIT' rules. The minimum and maximum field values (field bounds) for a number of fields within **ControlMate** commands can be set via the *Tools* → *Options* → *Limits* tab within the application. This in turn updates the respective module configuration file. The values that can be set are listed below (the example values are actual values for the volume fields within the **Thermo Scientific Matrix PlateMate 2x3** module):

Parameter	Description	File Example
Rule name	Index name by which the rule is referenced	Limit_01
Pseudo rule name	'Human' readable rule name	VOLUME
Minimum value	The lower bound field value	0.5
Maximum value	The upper bound field value	30
Caption	A textual value that is displayed to the user	Aspirate or Dispense volume
Unit	Unit of measurement	μl
Edit lock	Read only locking flag used to allow (value of 0) or disallow (value of 1) editing via the <i>Tools</i> → <i>Option</i> → <i>Limits</i> tab	1

External parameters may change the values within the rules set. For example, changing a **Thermo Scientific Matrix PlateMate 2x3** head type would change the *Volume* rules settings.

B.3 Sequential Sequence Checking

The relationship between commands within a programmed sequence are validated by applying the sequential sequence rules. This allows values in a program to be checked prior to running the sequence on the device. This ensures that the maximum liquid handling accuracy and device protection is achieved. The process of applying the rules allows the creation of external 'registers' or 'variables' against which the rules are compared. These registers can be incremented, decremented or set with literal values by each individual command. The setting of the value can also be determined by either setting it literally or by logic selection (conditional processing).

The rules can only be entered into the configuration file by a text editor, there is no rules editor available at this time.

The rules are very flexible and allow the creation of parameter strings by which individual commands or entire sequences can be checked. They are created as a **Rule Declaration** and then by applying a rule to a **specific command**. The format of each is shown below.

B.3.1 Rule Declaration

A rule has to first be declared before it can be used. The basic principal of a rule declaration is to ensure that the rule is added to a library of available rules and consists of creating a rule identifier, comparator, operand and failure text message. The comparator value can be either a literal value or a field bounds rule element (minimum or maximum value).

Comparison with a Field Bounds Rule element

Example:

Sequence_01 = MINVOL < @LIMIT_01.MIN, Total volume too low

This example creates a rule, 'MINVOL', which will compare a register value with the field bounds rule 'LIMIT_01' and if found to be less than the minimum setting for this field bounds rule will display the message 'Total volume too low'.

The ***Thermo Scientific Matrix PlateMate 2x3*** configuration file has the following rule declarations :

```
Sequence_01 = MINVOL < @LIMIT_01.MIN, Total volume too low
Sequence_02 = MAXVOL > @LIMIT_01.MAX, Total volume too high
Sequence_03 = DISPENSEVOL < 0, Total volume after dispense
too low
Sequence_04 = ASPIRATEMOVE < 1, No Move to tips prior to
Aspirate
Sequence_05 = DISPENSEMOVE < 1, No Move to tips prior to
Dispense
```

Comparison with a literal value

Example:

Sequence_03 = DISPENSEVOL < 0, Total volume after dispense too low

This example creates a rule, 'DISPENSEVOL', which will compare a register value with zero. If it is found to be negative, will display the message 'Total volume after dispense too low'.

B.3.2 Applying a Rule

A sequence rule is applied in one of two ways, selectively for each command. **A command does not have to apply a rule or change a register's value.**

Changing a Register's value

A command can change a register's value by applying a 'SET' instruction.

Example:

The **Matrix PlateMate 2x3** Dispense command will apply the following rule

```
Sequence_Rule_Set =
@optDispenseAll = 1 ? MINVOL = 0,
@optDispenseAll = 1 ? MAXVOL = 0,
@optDispenseAll = 1 ? DISPENSEVOL=0,
@optBlowOut = 1 ? MINVOL = 0,
@optBlowOut = 1 ? MAXVOL = 0,
@optBlowOut = 1 ? DISPENSEVOL = 0,
@optVolume = 1 ? MINVOL -= @txtVolume,
@optVolume = 1 ? MAXVOL -= @txtVolume,
@optVolume = 1 ? DISPENSEVOL -= @txtVolume
```

In this example the following is done:

- The MINVOL register is set to zero if the field optDispenseAll has a value of '1'. Command field names are prefixed with an '@' symbol
Logic checks are defined with a '?' symbol
- The MAXVOL register is set to zero if the field optDispenseAll has a value of '1'.
- The DISPENSEVOL register is set to zero if the field optDispenseAll has a value of '1'.
- The MINVOL register is set to zero if the field optBlowOut has a value of '1'.
- The MAXVOL register is set to zero if the field optBlowOut has a value of '1'.
- The DISPENSEVOL register is set to zero if the field optBlowOut has a value of '1'.
- The MINVOL register is decremented by the value of the txtVolume field if the field optVolume has a value of '1'.
- The MAXVOL register is decremented by the value of the txtVolume field if the field optVolume has a value of '1'.

- The DISPENSEVOL register is decremented by the value of the txtVolume field if the field optVolume has a value of '1'.
The **Thermo Scientific Matrix PlateMate 2x3 Aspirate** command will apply the following rule

```
Sequence_Rule_Set =  
MINVOL += @txtVolume,  
MAXVOL += @txtVolume,  
DISPENSEVOL += @txtVolume,  
@chkAirGap=1 ? MINVOL += @txtAirGap,  
@chkAirGap=1 ? MAXVOL += @txtAirGap,  
@chkAirGap=1 ? DISPENSEVOL += @txtAirGap
```

- The MINVOL register is incremented with the value of the txtVolume field

Notes:

A command's field value is referenced by its name and is prefixed with the '@' symbol.

This is a fixed assignment, i.e. the register will always be changed and is not logic based.

- The MAXVOL register is incremented with the value of the txtVolume field
- The DISPENSEVOL register is incremented with the value of the txtVolume field
- The MINVOL register is incremented with the value of the txtAirGap field if the chkAirGap value is '1', this means that if the Air Gap checkbox is checked then the register is incremented
- The MAXVOL register is incremented with the value of the txtAirGap field if the chkAirGap value is '1'
- The DISPENSEVOL register is incremented with the value of the txtAirGap field if the chkAirGap value is '1'

Using a register's value

Each command can have a setting which identifies which rule to apply.

Note: Commands do not have to apply rules. It is feasible for a command to set register values but not check them. For example, a Move command can set a register value that identifies that a stage has been positioned at the tips yet has no sequence rule check. Similarly, it is feasible for a rule to check a rule but not set a register value.

Example:

The **Thermo Scientific Matrix PlateMate 2x3 Aspirate** command applies the following :

Sequence_Rule_Check = MINVOL, MAXVOL, ASPIRATEMOVE

In this example the rules declared as MINVOL, MAXVOL and ASPIRATEMOVE will be applied (see previous examples for reference).

B.4 Rule Validation

B.4.1 Field Bounds Rules

Field Bounds rules are validated during the edit process. Whenever the 'Set' button is clicked the rules are applied (if applicable). If the Auto Correct checkbox is checked within the **Tools → Options → Limits** tab then a failed field value will be corrected as follows:

- If the value is less than the minimum rule value, then it will be set to the minimum value
- If the value is greater than the maximum rule value, then it will be set to the maximum value
- If auto correction is not required, then a message will be displayed for each field rule failure. The text displayed will be that as defined within the rules parameters along with the field minimum and maximum limits for reference.

File execution will not be allowed if a Field Bounds rule has failed.

B.4.2 Sequential Sequence Rules

The *Run → Validate File* option will apply the Sequential Sequence rules. The process is also applied whenever the file execution "Start" button is selected. If a sequence fails validation then the file execution is cancelled.

Note: Once a file has passed validation, it can be used to control a device, unless a command is changed (added, deleted, moved or a field amended), it does not need further validation. This reduces the startup time when issuing the sequence to the device.

C Precision Data

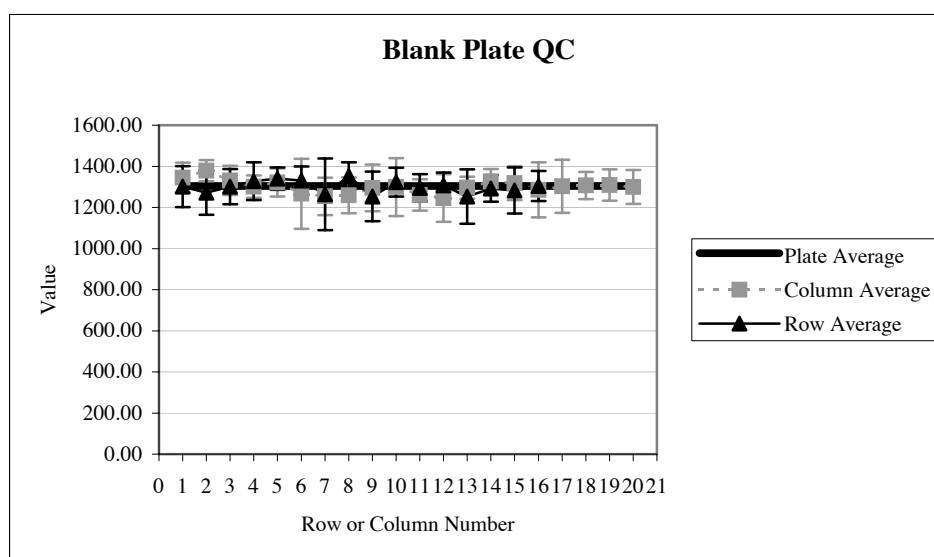
C.1 Precision at 0.5µl into a dry 384 well plate

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a	1362	1317	1405	1369	1365	1028	1229	1165	1410	1278	1200	1305	1269	1351	1257
b	1372	1305	1216	1324	1181	1372	1261	1286	1187	1177	1411	934	1305	1333	1209
c	1451	1371	1274	1287	1344	1266	1200	1419	1345	1228	1121	1265	1289	1364	1337
d	1426	1478	1365	1256	1389	1400	1186	1324	1335	1485	1309	1255	1294	1312	1406
e	1344	1375	1394	1310	1366	1355	1331	1283	1342	1452	1300	1333	1296	1415	1330
f	1442	1444	1310	1337	1335	1316	1365	1204	1283	1331	1185	1339	1392	1215	1362
g	1381	1427	1307	1382	1323	729	1286	1289	955	1011	1223	1277	1315	1326	1266
h	1433	1389	1406	1259	1304	1358	1403	1369	1385	1401	1405	1348	1331	1388	1397
i	1329	1323	1444	1207	1363	1356	1245	1232	1209	1068	1307	1239	1323	1288	1211
j	1371	1312	1375	1370	1296	1364	1350	1209	1300	1391	1260	1260	1227	1246	1486
k	1228	1361	1375	1287	1400	1370	1211	1193	1258	1422	1292	1285	1223	1335	1261
l	1303	1414	1310	1266	1404	1244	1312	1245	1249	1400	1228	1241	1263	1315	1283
m	1285	1410	1317	1242	1255	1202	1019	1330	1424	1286	1219	1290	1191	1242	1310
n	1294	1402	1224	1242	1370	1328	1188	1285	1351	1228	1242	1311	1311	1291	1413
o	1277	1412	1227	1305	1249	1247	1264	1050	1311	1187	1260	993	1387	1428	1360
p	1228	1325	1354	1377	1204	1331	1210	1256	1373	1440	1211	1256	1320	1376	1204

0.5ul incr plate1 no blow tip touch
Plate average 1303.5 Plate SD 95.543 Plate CV 7.3%
 Stats calculated from Control Wells Only

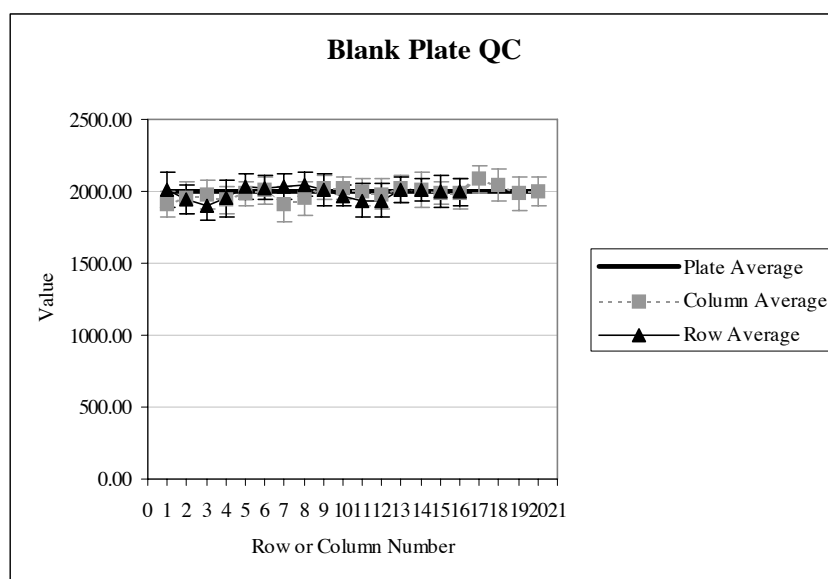
Column or Row	Column average	Column SD	Column CV	Row Average	Row SD	Row CV	Plate average	Value
1	1345.38	72.19	5.37%	1300.70	99.47	7.65%	1303.53	High Control 1292.81
2	1379.06	51.96	3.77%	1271.85	107.78	8.47%	1303.53	High Control SD 84.39
3	1331.44	70.14	5.27%	1301.40	85.77	6.59%	1303.53	Low Control 1348.41
4	1301.25	54.68	4.20%	1327.20	91.54	6.90%	1303.53	Low Control SD 67.69
5	1321.75	68.48	5.18%	1340.70	54.46	4.06%	1303.53	Signal window -6.69
6	1266.63	170.22	13.44%	1330.95	68.65	5.16%	1303.53	Z 9.21
7	1253.75	91.58	7.30%	1263.80	173.90	13.76%	1303.53	Signal/Noise -0.51
8	1258.69	86.86	6.90%	1353.30	66.19	4.89%	1303.53	Signal/Background 0.96
9	1294.81	113.16	8.74%	1253.65	120.29	9.59%	1303.53	Whole Plate Max value 1486
10	1299.06	140.84	10.84%	1323.00	69.61	5.26%	1303.53	Whole Plate Min value 729
11	1260.81	75.89	6.02%	1295.70	66.00	5.09%	1303.53	
12	1245.69	115.73	9.29%	1307.15	63.22	4.84%	1303.53	
13	1296.00	53.96	4.16%	1253.50	132.26	10.55%	1303.53	
14	1326.56	60.90	4.59%	1292.05	64.63	5.00%	1303.53	
15	1318.25	82.76	6.28%	1282.55	112.05	8.74%	1303.53	
16	1285.25	134.01	10.43%	1304.35	73.36	5.62%	1303.53	
17	1302.81	128.69	9.88%				1303.53	
18	1306.63	65.86	5.04%				1303.53	
19	1308.69	75.86	5.80%				1303.53	
20	1299.81	82.41	6.34%				1303.53	

3xSD 253.17174
 mean+3SD 1545.98
 Mean-3SD 1039.64
 To find values outside 3*SD of control wells press



C.2 Precision at 1.0µl into a dry 384 well plate

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	1957	2287	2001	1887	2057	1978	2101	2102	2022	1997	1931	2069	2086	1683	2086
B	1908	1812	1792	1886	2003	2112	2007	1902	1862	1963	1910	1931	2147	2099	1880
C	1790	1934	1902	1768	1870	1861	1761	1908	1974	2087	1832	1783	1896	1830	2034
D	1998	1849	1955	1813	2026	1952	1641	2134	2003	1946	1980	2118	2048	2055	1954
E	1836	1851	2133	2035	2035	2042	2011	2021	2175	2041	2080	2113	1986	2003	2083
F	1878	2063	2019	2086	2042	2115	2036	1978	2010	2180	2094	2026	2073	1981	1971
G	1993	1991	2000	2109	2126	2024	2028	1931	1998	2088	2022	1823	2100	2035	2072
H	1967	2016	2077	1906	2124	1994	1977	2041	1985	2046	2107	2019	2195	1945	1961
I	1911	1950	2128	1925	1964	2153	1871	2047	2022	2046	1856	2082	2035	2015	1984
J	1857	1931	2039	1873	1913	2005	1817	1952	1987	2035	1943	2051	1919	2020	1974
K	1755	1906	1785	1997	1954	1947	1921	1703	2159	1950	1956	1934	1854	2113	2015
L	1796	1890	1911	1974	1875	2148	1707	1718	2031	1911	1940	1951	1953	1980	1840
M	2076	1848	2049	1877	1931	2023	1931	1951	2095	2116	2064	1942	2027	1965	2086
N	1997	1958	2008	1964	2008	1903	1942	1916	1915	1979	2064	2075	1908	2175	2031
O	1883	2014	1959	1990	1847	1850	1863	2026	2149	2092	1981	1889	1981	2047	1926
P	1976	2007	1949	1981	1986	1997	1963	1882	2035	1898	2172	1922	2089	2182	1926
Volume = 1.0ul															
Plate average		1996.46		Plate SD		105.1		Plate CV		5.26%					
Stats calculated from Control Wells Only															
Column or Row	Column average	Column SD	Column CV	Row Average	Row SD	Row CV	Plate average	Value							
1	1911.13	89.82	4.70%	2013.15	124.50	6.18%	1996.46	High Control 2030.63							
2	1956.69	113.92	5.82%	1946.60	102.32	5.26%	1996.46	High Control SD 93.43							
3	1981.69	100.77	5.08%	1902.00	96.53	5.08%	1996.46	Low Control 2014.66							
4	1941.94	92.84	4.78%	1950.70	126.86	6.50%	1996.46	Low Control SD 83.19							
5	1985.06	84.28	4.25%	2030.70	90.88	4.48%	1996.46	Signal window -5.81							
6	2006.50	93.16	4.64%	2025.00	82.23	4.06%	1996.46	Z' -32.18							
7	1911.06	127.25	6.66%	2031.45	87.26	4.30%	1996.46	Signal/Noise 0.13							
8	1950.75	118.68	6.08%	2047.50	81.89	4.00%	1996.46	Signal/Background 1.01							
9	2026.38	84.30	4.16%	2014.70	112.49	5.58%	1996.46	Whole Plate Max value 2287							
10	2023.44	78.97	3.90%	1972.05	72.24	3.66%	1996.46	Whole Plate Min value 1641							
11	1995.75	95.23	4.77%	1938.50	113.42	5.85%	1996.46								
12	1983.00	101.50	5.12%	1936.10	118.86	6.14%	1996.46								
13	2018.56	96.25	4.77%	2015.75	89.42	4.44%	1996.46								
14	2008.00	122.96	6.12%	2009.45	79.14	3.94%	1996.46								
15	1988.94	74.66	3.75%	2000.95	106.51	5.32%	1996.46								
16	1985.44	104.70	5.27%	1999.50	94.02	4.70%	1996.46								
17	2085.50	91.55	4.39%				1996.46								
18	2043.94	111.55	5.46%				1996.46								
19	1986.69	116.48	5.86%				1996.46								
20	2002.19	96.84	4.84%				1996.46								
21	2049.88	517.72	25.26%				1996.46								
22	2043.31	533.80	26.12%				1996.46								
23	2045.69	533.14	26.06%				1996.46								
24	1983.63	559.37	28.20%				1996.46								
3xSD 280.288															
mean+3SD 2310.91															
Mean-3SD 1750.34															
To find values outside 3*SD of control wells															



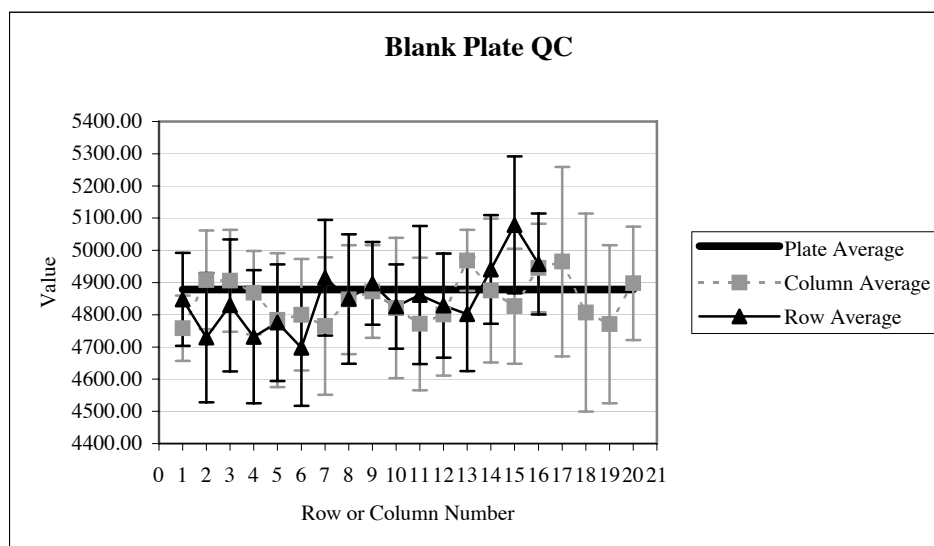
C.3 Precision at 2.5µl into a wet 384 well plate

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	4784	4992	4899	4803	4866	5102	4586	4888	4964	4815	4581	4842	4985	4732	4858
B	4575	4995	5057	4727	4458	4541	4666	4612	4964	4628	4394	4826	4881	4697	4824
C	4825	5012	4958	4976	5217	4980	4407	4754	4733	4703	4690	5016	4823	4526	4878
D	4765	4982	4929	4962	4489	4810	5105	4645	4607	4816	4553	4541	5018	4715	4683
E	4629	4649	4566	4983	4791	4654	4915	5041	4798	4542	4982	4933	5142	4781	4686
F	4720	4808	4719	5049	4909	4538	4496	4698	4994	4619	4663	4509	4952	4413	4625
G	4913	4925	5049	4955	4883	4904	4813	4616	5094	5298	4800	4592	5103	5124	4910
H	4675	5238	4999	4892	4448	5037	4865	4908	5017	4986	4733	4807	4858	5013	4556
I	4651	4915	5045	4777	4697	4994	4883	4799	4933	5198	4787	4966	5000	4958	4940
J	4806	4925	4977	4784	4606	4712	4690	4857	4765	4704	4740	4986	4832	4823	4792
K	4860	4831	4656	4552	4870	4717	5030	4739	4838	4617	4816	4613	4900	5053	5088
L	4836	4927	4804	4994	4710	4616	4644	4886	4686	4591	4717	4703	4922	5045	4873
M	4711	4729	4853	4808	4971	4829	4493	4823	4686	4964	4666	4591	5049	4865	4609
N	4923	4654	4844	4807	4853	4693	5084	5051	4992	4857	5181	4858	5025	4964	4699
O	4773	4865	4990	4986	4960	4845	4847	5141	4989	4892	5150	5134	5049	5057	5184
P	4683	5082	5148	4843	4808	4827	4716	5096	4898	4908	4897	4894	4963	5240	5022

Volume = 2.5ul
Plate average 4877.8 Plate SD 208.78 Plate C.V. 4.28%
Stats calculated from Control Wells Only

Column or Row	Column average	Column SD	Column CV	Row Average	Row SD	Row CV	Plate average	Value
1	4758.06	101.07	2.12%	4847.90	144.00	2.97%	4877.84	High Control 5027.42
2	4908.06	153.30	3.12%	4728.90	201.30	4.26%	4877.84	High Control SD 191.49
3	4905.81	158.17	3.22%	4829.30	204.75	4.24%	4877.84	Low Control 5086.91
4	4868.63	129.53	2.66%	4731.65	207.02	4.38%	4877.84	Low Control SD 156.79
5	4783.50	208.05	4.35%	4775.55	181.33	3.80%	4877.84	Signal window -6.31
6	4799.94	172.99	3.60%	4698.05	180.66	3.85%	4877.84	Z' 18.56
7	4765.00	213.24	4.48%	4914.70	179.54	3.65%	4877.84	Signal/Noise -0.24
8	4847.13	169.21	3.49%	4848.95	200.86	4.14%	4877.84	Signal/Background 0.99
9	4872.38	144.09	2.96%	4897.40	128.40	2.62%	4877.84	Whole Plate Max value 5606
10	4821.13	217.46	4.51%	4825.40	131.05	2.72%	4877.84	Whole Plate Min value 4332
11	4771.88	205.84	4.31%	4861.40	214.58	4.41%	4877.84	
12	4800.69	189.00	3.94%	4828.45	161.71	3.35%	4877.84	
13	4968.88	94.83	1.91%	4802.05	176.98	3.69%	4877.84	
14	4875.38	223.22	4.58%	4940.90	168.56	3.41%	4877.84	
15	4826.69	178.69	3.70%	5078.80	212.62	4.19%	4877.84	
16	4945.19	137.10	2.77%	4957.45	156.83	3.16%	4877.84	
17	4965.00	294.47	5.93%				4877.84	
18	4806.69	307.72	6.40%				4877.84	
19	4770.69	245.67	5.15%				4877.84	
20	4897.88	176.12	3.60%				4877.84	
21	4954.31	1308.85	26.42%				4877.84	
22	4991.56	1347.78	27.06%				4877.84	
23	5153.81	1348.01	26.16%				4877.84	
24	5020.00	1413.70	28.16%				4877.84	

3xSD 574.471386
mean+3SD 5601.89
Mean-3SD 4452.95
To find values outside 3*SD of control wells press



C.4 Precision at 5.0µl into a wet 384 well plate

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	10431	10179	10375	9918	9852	10187	9677	10074	9774	9979	9994	10116	9873	10342	9633
B	10084	10123	10320	10065	9887	9780	9519	10181	10087	10005	9915	10019	10256	9634	9852
C	9839	9944	10260	10062	9875	10098	9873	10125	9724	9697	10129	10181	10130	9795	9818
D	9844	10013	10156	9952	10177	10082	9886	10002	10126	9844	10025	9663	10446	10124	10011
E	9490	10147	10161	9996	10246	9698	9885	9977	10313	9878	10026	10155	10424	10206	10197
F	9950	10153	9962	10183	10036	10110	9877	10045	10061	10501	10204	10213	10457	9838	10027
G	10218	10171	10305	10209	10459	10450	10030	10268	10222	10966	9987	10361	10698	10137	10031
H	9920	10156	10178	9878	10091	10011	9889	10349	10284	10310	10230	10535	10405	10225	10213
I	10050	9908	10040	10141	10095	10234	9695	10193	10034	11056	10072	10748	10518	10294	10367
J	9803	9642	9939	9708	9772	10083	9832	9856	10209	10175	10077	10134	10056	10026	9967
K	9673	9721	9994	9609	9909	9860	9664	10121	10165	10174	10014	10015	10145	10268	10156
L	9531	9612	9959	9622	9702	9848	9943	10149	10098	9991	10058	9987	10324	10414	9873
M	9875	9765	9943	9882	9854	10296	10040	10314	10137	10423	10263	10480	10352	10504	10258
N	9606	9736	10042	9788	9871	10022	9656	10084	10151	10196	10177	10228	10468	10242	10097
O	9593	9715	9922	9854	9790	9548	9485	10019	9833	10260	9711	10123	10031	10212	10234
P	9654	9943	10273	9956	10041	9743	9517	10090	10127	9977	9732	10507	10293	10431	10018

Volume = 5.0ul

Plate average10072.9Plate SD253.67Plate C.V.2.52%

Stats calculated from Control Wells Only

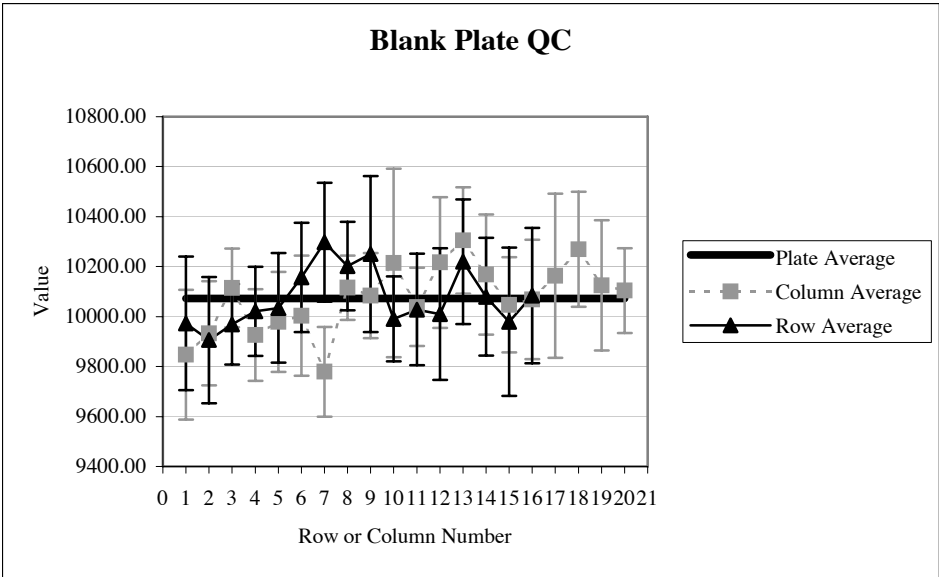
Column or Row	Column average	Column SD	Column CV	Row Average	Row SD	Row CV	Plate average	Value
1	9847.56	259.77	2.64%	9973.15	266.96	2.68%	10072.94	High Control10062.16
2	9933.00	208.43	2.10%	9905.85	252.10	2.54%	10072.94	High Control SD235.72
3	10114.31	157.19	1.55%	9969.10	161.03	1.62%	10072.94	Low Control10059.69
4	9926.44	183.60	1.85%	10020.85	178.08	1.78%	10072.94	Low Control SD278.03
5	9978.56	199.48	2.00%	10034.20	219.30	2.19%	10072.94	Signal window-5.97
6	10003.13	240.59	2.41%	10156.95	218.11	2.15%	10072.94	Z'-623.31
7	9779.25	179.36	1.83%	10297.60	237.24	2.30%	10072.94	Signal/Noise0.01
8	10115.44	128.00	1.27%	10202.25	177.10	1.74%	10072.94	Signal/Background1.00
9	10084.06	170.59	1.69%	10250.05	312.09	3.04%	10072.94	Whole Plate Max value11056
10	10214.50	377.46	3.70%	9990.65	169.83	1.70%	10072.94	Whole Plate Min value9361
11	10038.38	156.38	1.56%	10028.05	223.22	2.23%	10072.94	
12	10216.56	261.80	2.56%	10010.30	263.39	2.63%	10072.94	
13	10304.75	212.69	2.06%	10219.60	248.82	2.43%	10072.94	
14	10168.25	240.43	2.36%	10079.35	236.32	2.34%	10072.94	
15	10047.00	191.08	1.90%	9979.20	296.30	2.97%	10072.94	
16	10068.13	239.13	2.38%	10084.35	270.95	2.69%	10072.94	
17	10163.44	328.46	3.23%				10072.94	
18	10269.31	229.85	2.24%				10072.94	
19	10125.44	260.81	2.58%				10072.94	
20	10104.38	169.38	1.68%				10072.94	
21	10063.88	2842.13	28.24%				10072.94	
22	10065.38	2870.59	28.52%				10072.94	
23	10264.13	2855.89	27.82%				10072.94	
24	9855.25	2985.16	30.29%				10072.94	

3xSD707.171674

mean+3SD10769.33

Mean-3SD9354.98

To find values outside 3*SD of control wells press CTRL+m



D Warranty and Customer Service

Contact Us With Your Questions and Comments

Your Thermo Scientific Matrix PlateMate 2x3 and pipetting heads are covered by a one year factory warranty. Your comments and suggestions for improving the performance and versatility of the **Thermo Scientific Matrix PlateMate 2x3** system are always welcome and appreciated. We also appreciate your comments and suggestions for improving this manual. If you have any questions or comments about your **Thermo Scientific Matrix PlateMate 2x3** system, contact your equipment provider. Some of those contacts are listed on this page; if your instrument was provided by a distributor not listed here, contact that distributor.

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