MATRIX
PLATEMATE PLUS
User Manual

Thermo
SCIENTIFIC

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Revision 1.0.

Table of Contents

1 Introduction

The ***PlateMate Plus***™ Liquid Transfer Device is a versatile, automated pipetting workstation that is capable of pipetting, diluting, dosing, dispensing, and rinsing. Its high precision and modular design make it the instrument of choice for a wide range of liquid-handling applications.

Interchangeable pipetting heads allow you to easily switch from the 96-well channel to the 384-well plate formats.

Configured with two or four stackers, the ***PlateMate*** Stacker system dramatically reduces the time required to transfer liquid to multiple microplates. It can automatically process up to 50 microplates per stacker.

With user-friendly software running under MS-Windows, operators in chemical, biological, physical and in-vitro medical laboratories can quickly and easily customize specific laboratory protocols.

1.1 System Features

The ***PlateMate Plus*** base unit provides a universal platform upon which a flexible automated workstation is built. This platform supports four removable stacker chimneys, deep or shallow well plates, any of the standard interchangeable pipetting heads, and a host of other system accessories.

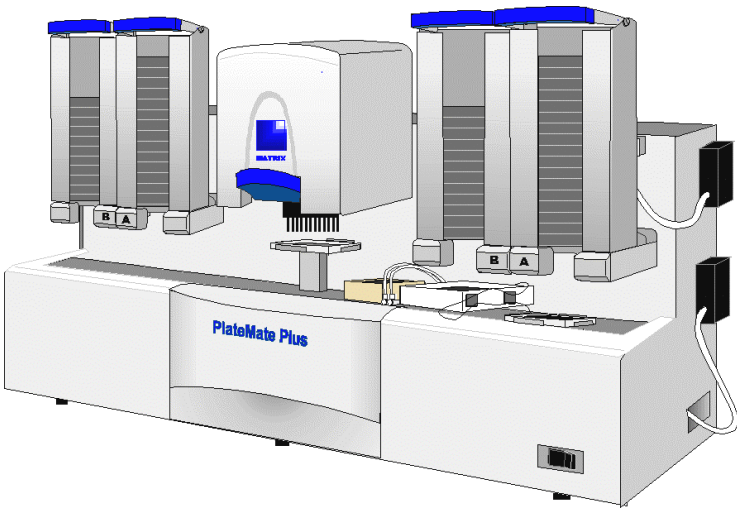


Figure 1: PlateMate Plus System

A base unit includes the following standard features:

- 4-position micro plate deck allows easy plate or reservoir placement onto the device.
- High-resolution linear plate movement allows accurate (±0.05mm) microplate positioning of 96, 384, 864, and 1536 well plates.
- Torque limited 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.
- Supports up to four universal stacker chimneys (tall or short), which allows operators to select the quantity and style of stacker chimneys to be used.
- Interchangeable pipetting heads are a powerful feature that provides optimal performance and flexibility for either 96 or 384 channel pipetting applications.

Efficient pipette tip replacement

MATRIX D.A.R.Ts™ (Disposable Automated Research Tips) are compatible with the ***PlateMate Plus*** 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 0-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 fiat-bottom microplate surfaces. Filter tip options are available for disposable tips.

Serial dilution feature

To further expand the versatility of the ***PlateMate Plus***, MATRIX has designed the system to support 8- or 16-channel serial dilution applications. This is accomplished by using a dedicated 8- or 16-channel tip magazine with the appropriate 96- or 384-channel pipetting head. The instrument's discrete x/y motion allows for incremental plate movement for row-by-row dilutions directly on the ***PlateMate Plus***.

Volumetric calibration

PlateMate Plus 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. Using the ***ControlMate*** software interface, calibration for specific liquids can be performed quickly in the lab. Unlimited calibration settings (or liquid types) can be stored in memory and applied when needed. Volume calibration is a feature found on all MATRIX liquid handling systems.

Removable microplate stackers

All ***PlateMate Plus*** base units are capable of supporting up to four microplate stacker chimneys. These chimneys are available in two sizes, short (25 microplates) and tall (50 microplates). Chimneys are universal in design and can be readily interchanged on the base unit. Extra chimneys may be purchased for off-line microplate loading and transport. Stacks are universally compatible with deep or shallow well plates of varying footprints.

1.2 About this Manual

To use your new ***PlateMate Plus*** 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 ***PlateMate Plus***, 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 Matrix Technologies Corporation of Hudson, New Hampshire, immediately, at the address on the cover of this manual.

Matrix Technologies 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.

1.3 Manual Conventions

References to other sections in the manual are shown in italic text.	See *Chapter 4, ControlMate Software,* 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 *All* 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 microplate carriage and lifter.
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 ***PlateMate Plus*** 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 ***PlateMate Plus*** provides fast, flexible and precise automated liquid delivery while ensuring zero carryover, thereby greatly reducing the risk of contamination.

2.2 Instrumentation

2.2.1 System Configuration

This section summarizes the standard components in the base system and the optional components that can be added.

Standard Configuration

The ***PlateMate Plus*** base unit provides a universal platform upon which a flexible automated workstation is built.

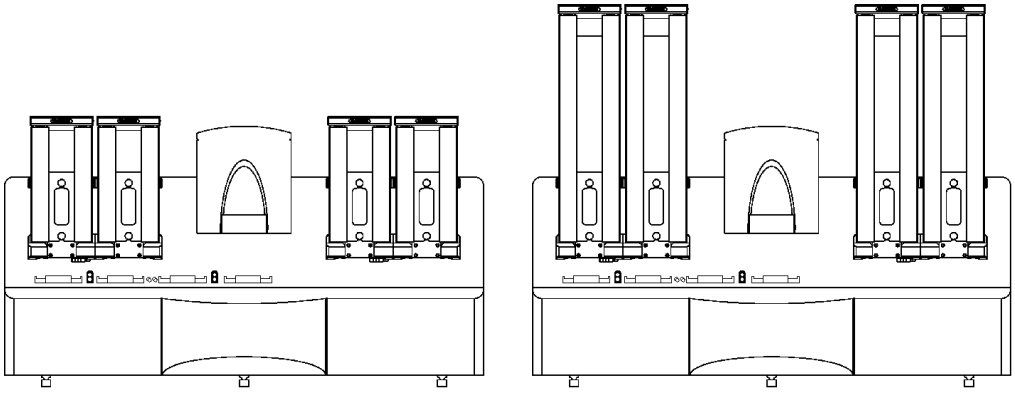


Figure 2: PlateMate Plus with Short Stackers *PlateMate Plus with Tall Stackers*

The base unit includes the following System Components:

- 4-position microplate deck
- 4 microplate adapters
- Stepper motors for plate positioning (supports 96, 384, 864, and 1536 well plates; also supports deep or shallow wells)
- 2 peristaltic pumps and liquid level sensors for reagent and wash fluid
- 1 vacuum pump

- Keyboard unit for manual control
- ***ControlMate*** Windows-based PC interface software for sequence-based program creation and editing, plus OLE option for robotic integration
- Support frames for four universal stacker chimneys

Optional Components

The ***PlateMate Plus*** platform supports the following optional components:

- Tall and short stack chimneys (maximum of 4 chimneys)
- Interchangeable pipetting head:
  - 96-well (300 µL) head
  - 96-well (30 µL) head
  - 384-well (100 µL) head
  - 384-well (30 µL) head
- Tip wash stations
- Tip transfer tool
- Tip magazine
- Reagent reservoirs
- Barcode reader

2.2.2 System Components

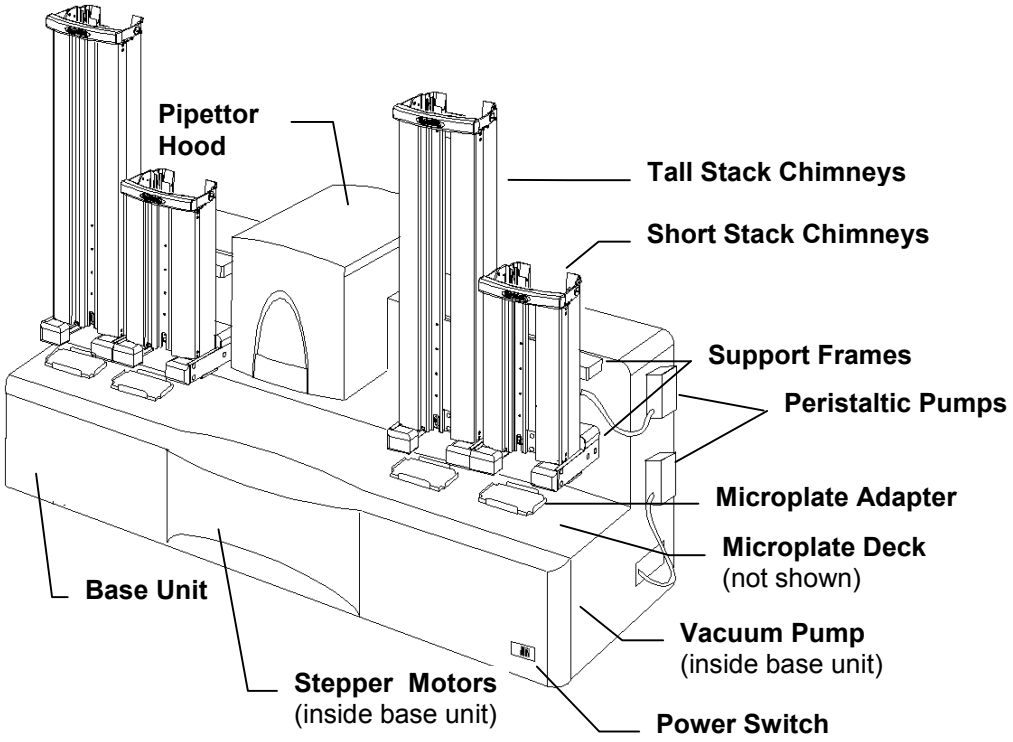


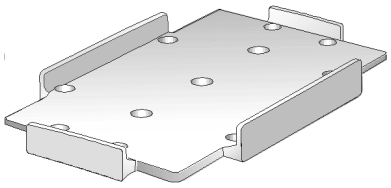
Figure 3: PlateMate Plus Components

Main System Components

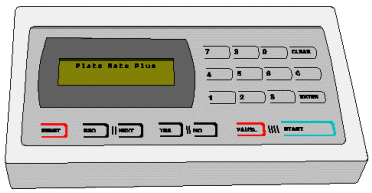
Base Unit: Base unit contains four independent stepper motors for vertical microplate movement of stages 1 to 4. The motors are software-controlled through the PC or manual keyboard. This component also contains all of the electronic controls.

The Base Unit includes the following components:

- **Stepper motors:** Independent stepper motors move the microplate stages vertically and horizontally.
- **Power Switch:** Rocker switch turns ***PlateMate Plus*** on or off.
- **Vacuum pump:** Removes waste fluid from the tip wash station.
- **Microplate deck:** Microplate deck contains four microplate stages. Supports 96, 384, 864, and 1536 well plates; also supports deep or shallow wells).
- **Microplate adapters:** Standard microplate adapters support 96 and 384-well microplates. Custom microplate adapters are available to support 1536-well plate and other microplate types (polypropylene, polystyrene).



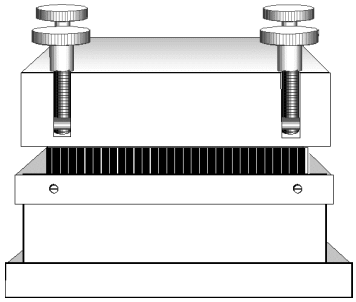
- **Peristaltic pumps:** Two pumps, mounted on the side of the base unit, supply fluid to the reagent reservoir or tip wash station on the microplate deck. Uses liquid level sensors for overflow detection and continuous fluid replenishment (when used with reagent reservoir).
- **Keypad:** Manual keypad provides direct control of the microplate deck for basic microplate positioning or troubleshooting.



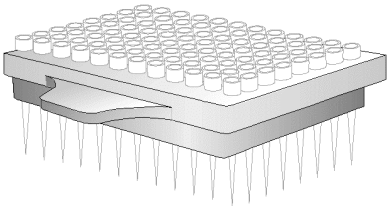
- ***ControlMate* Software:** Windows-based PC interface software for sequence-based program creation and editing, plus OLE option for robotic integration.
- **Support frames:** Holds stack chimneys to base unit. These frames can be removed easily to accommodate gripper arms, if necessary.
- **Tall and short stack chimneys:** Stack chimneys enable the operator to prepare multiple microplates automatically. Tall stack chimneys can accommodate up to 50 microplates; short stack chimneys can accommodate up to 25 microplates.
- **Pipettor Hood:** Houses pipettor head and tips magazine. Front panel can be raised to allow access to the internal components.

Other System Components:

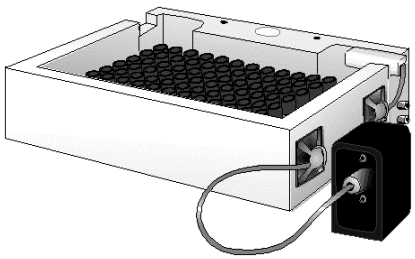
Pipettor Head: Interchangeable head that can be easily inserted into or removed from the base unit. Contains a silicone gasket that forms an airtight seal with tips in the tips magazine. Pipettor heads are available with 96, 384, and 1536 channels.



Tips Magazine: Aluminum frame that holds 96, 384, or 1536 pipette tips. Disposable tips magazines (D.A.R.Ts) can be used with the ***PlateMate Plus***. Tips magazines with Teflon®-coated, steel tips are also available.

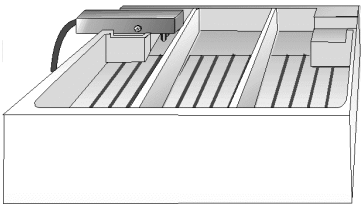


Tip wash station: Washes steel pipet tips, both interior and exterior walls. It is mounted on a microplate stage and connects to the buffer and waste lines; liquid-level sensor prevents overflow.



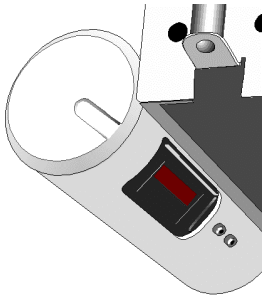
Tips transfer tool: Transfers pipet tips from a container to the tips magazine.

Reagent reservoir: Reagent vessel for dispensing limited volume of reagent. Two types of reagent reservoirs are available:



- 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.
- V-bottom stackable reservoir is placed in a stacker and moved through the system. Allows for more than one reagent on the system and uses the least volume of reagent.

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

2.2.3 Pre-installation Requirements

Before setting up your ***PlateMate Plus***, make sure that you provide sufficient bench space for the instrument, buffer, reagent containers, and computer system.

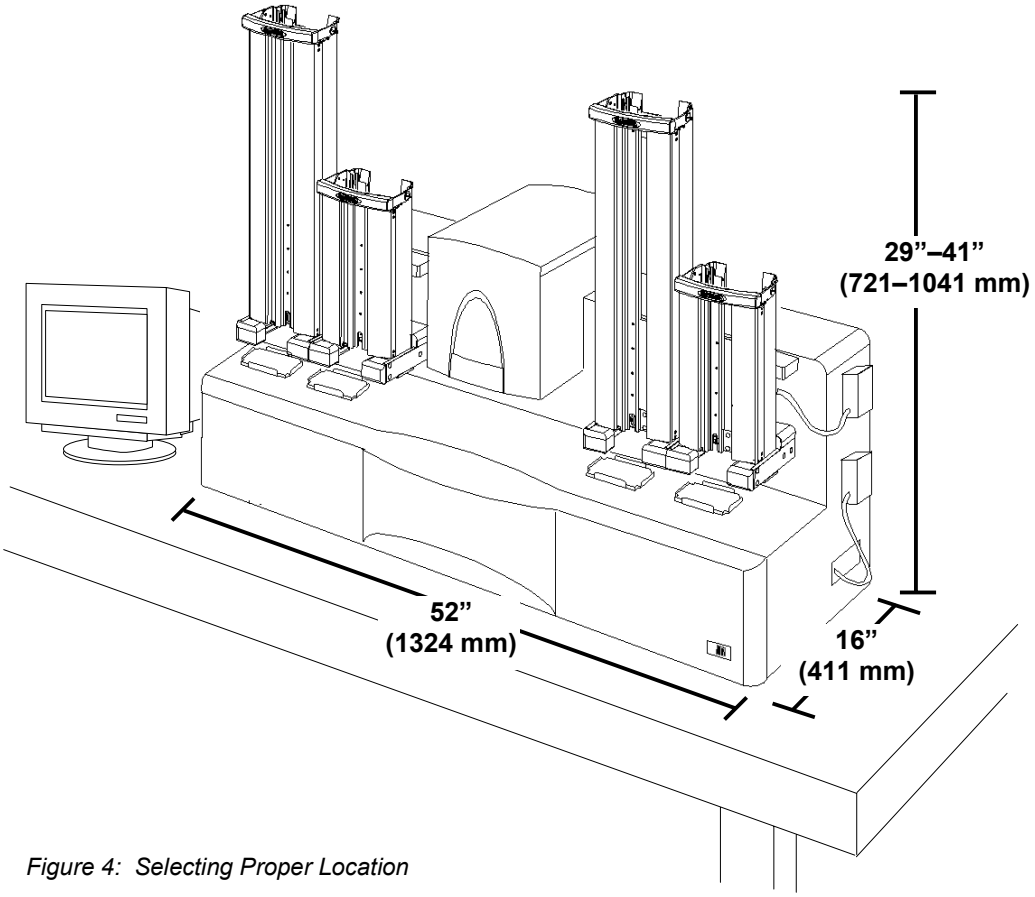


Figure 4: Selecting Proper Location

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

- Flat surface capable of holding l80 lbs (80 kg)
- Ventilation space: 52 in (1324 mm) width + 29 to 41 in. (721 to 1041 mm) height (short stacker/tall stacker) + 16 in (411 mm) depth (space around instrument)
- Bench space on left side for computer (6.5 ft. serial cable is provided)
- Bench space on right side for reagent supplies (approx. 1 ft.; 3 ft. tubing provided)
- Height to accommodate tallest stacker (4-5 in. taller than stacker)
- 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.

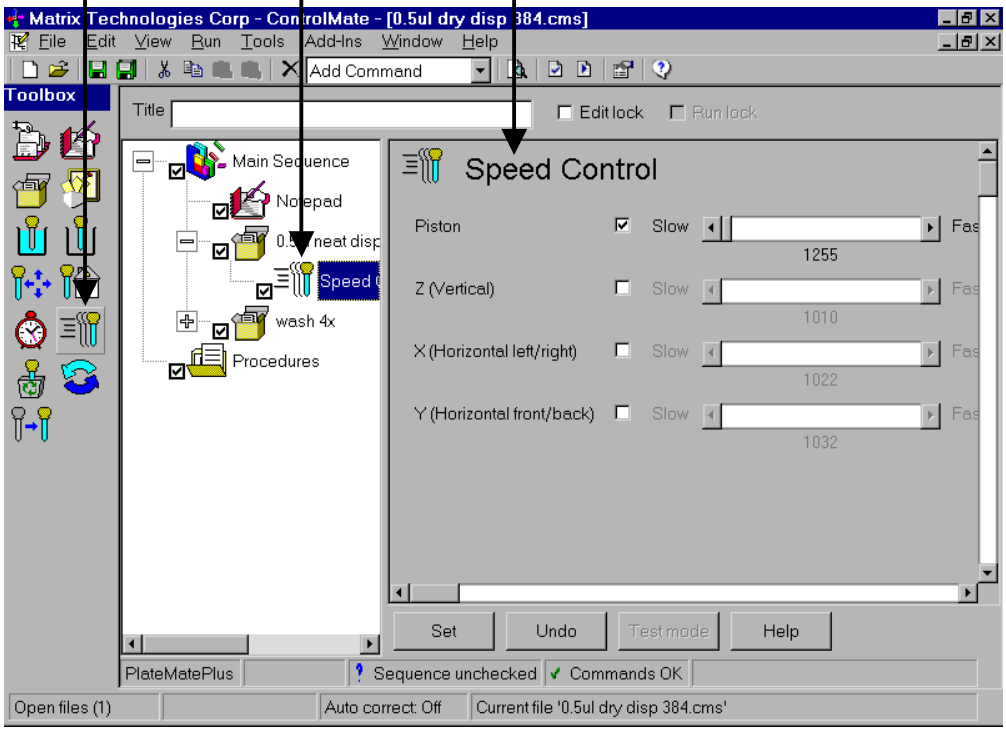
Note: See *Chapter 4, ControlMate Software*, for installation and operating instructions.

2.3.2 Creating a Program

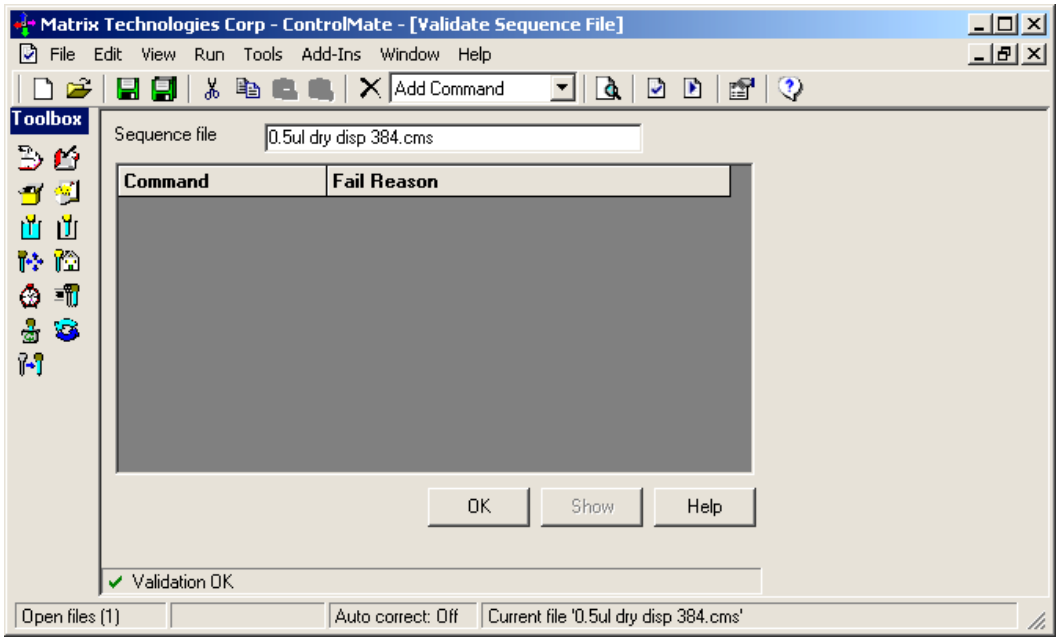
Pipetting programs are created in ***ControlMate*** by clicking the icons in the Toolbox. Each icon represents either a software command or pipetting command.

When you click an icon, the command it represents is added to the sequence of commands, called the Command Tree.

While the command is highlighted, you can enter the Command settings that are specific to that command

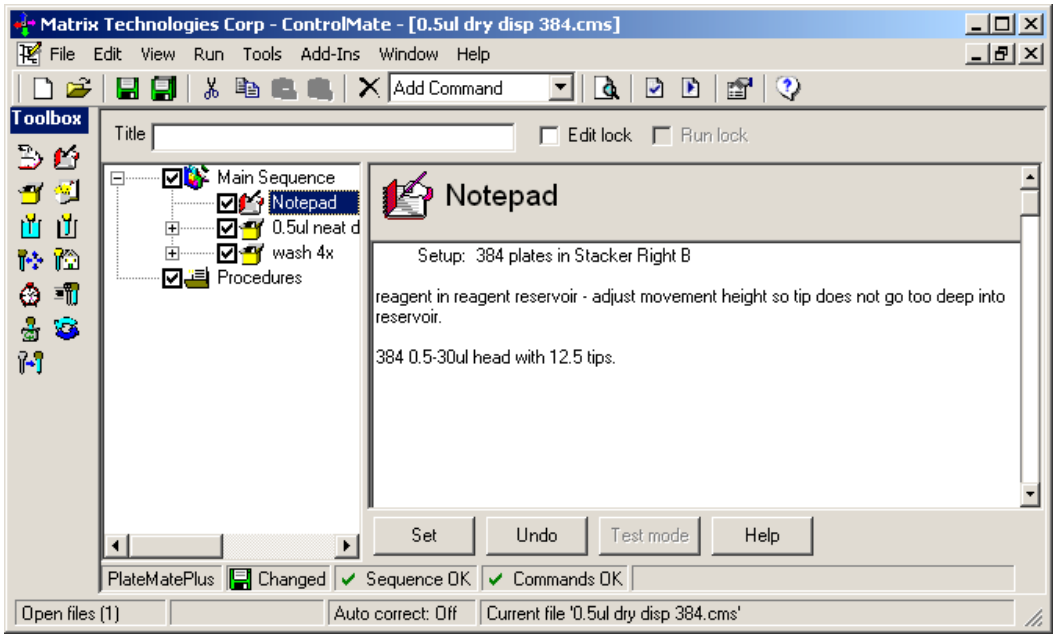


After you create a program, you can validate it in ***ControlMate*** before running it on the ***PlateMate Plus***.

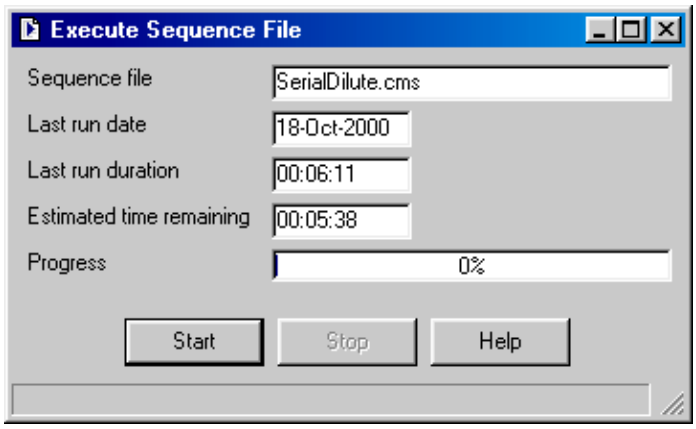


2.3.3 Running a Program

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.



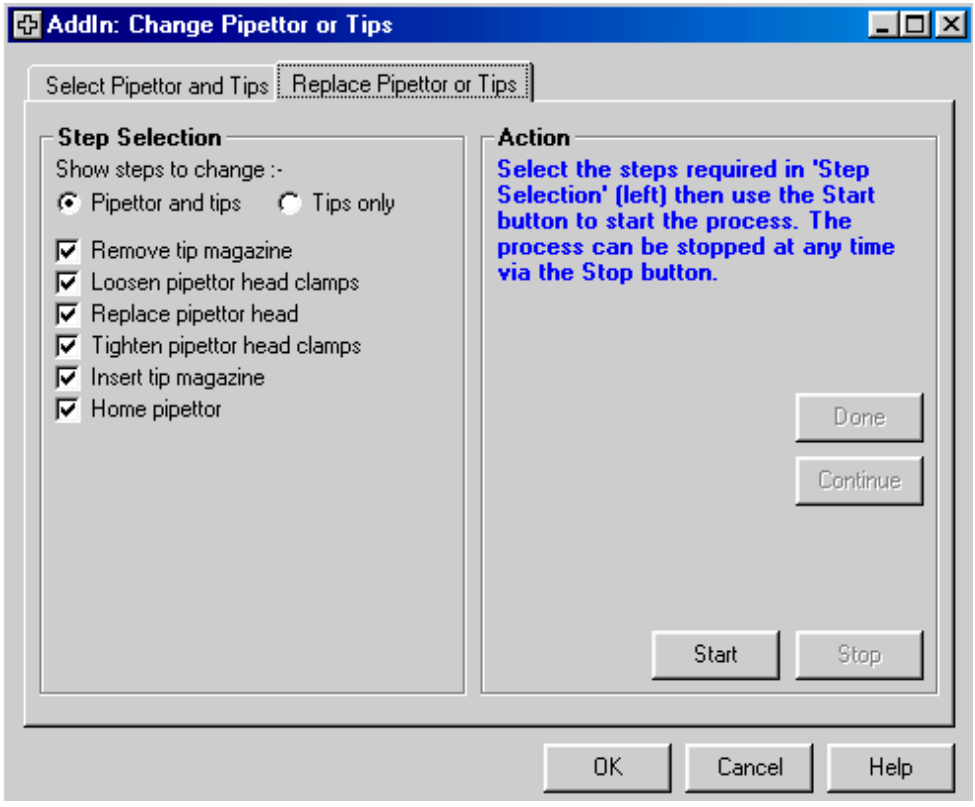
When you are ready, you can run the pipetting sequence.



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

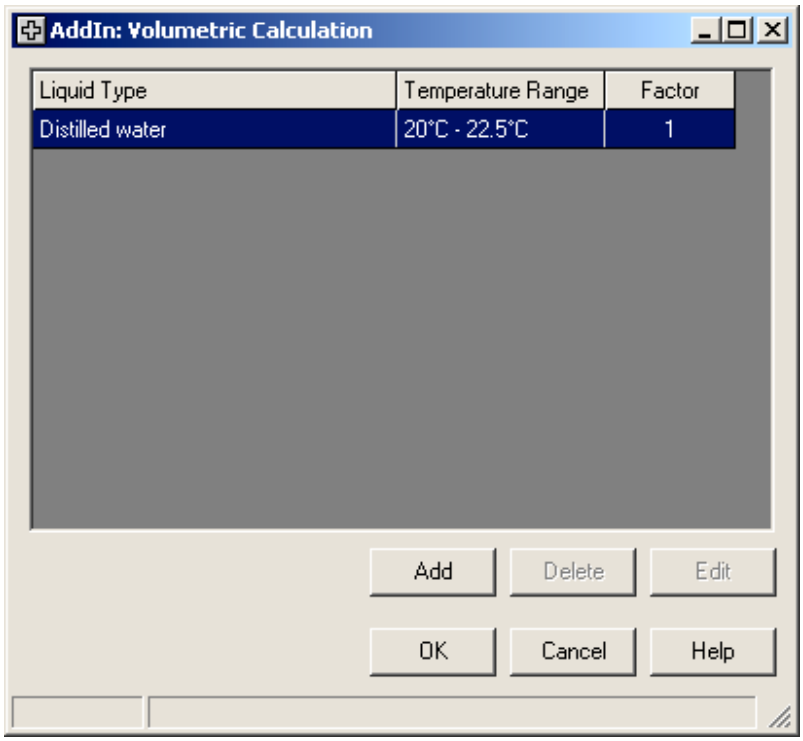
2.3.4 Changing *PlateMate Plus* Components

ControlMate software also provides step-by-step instructions to change ***PlateMate Plus*** 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.



2.4 Overview of Operation

2.4.1 Laboratory Application

Some of the possible laboratory applications for the ***PlateMate Plus*** 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 ***PlateMate Plus***
3. Set up ***PlateMate Plus***
   - ❑ Change microplate adapter
   - ❑ Attach stackers
   - ❑ Load microplates
   - ❑ Change pipettor head
   - ❑ Change tips
   - ❑ Attach Reagent Reservoir
   - ❑ Attach Tip Wash Station
   - ❑ Add ancillaries (buffer, water, reagent)
4. Run pipetting program
5. Shut down ***PlateMate Plus***

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

2.4.3 Device Precision

The ***PlateMate Plus*** 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 D, Precision Data*.

Table 1: Device Precision

Volume	Plate average	Plate SD	Plate C.V
0.5µl into a dry 384 well plate	35983	1067	2.965%
1.0µl into a dry 384 well plate	40159	786.77	1.959%
2.5µl into a wet 384 well plate	4877.8	208.78	4.28%
5.0µl into a wet 384 well plate	10073	253.67	2.52%

2.5 Specifications

2.5.1 System Specifications

Instrument Dimensions

Base unit weight	180 pounds (80 kilograms)	
Dimensions	Width:	52 inches (1324 millimeters)
	Height w/ Stackers	29 inches (721 millimeters) (short stackers) 41 inches (1041 millimeters) (tall stackers)
	Depth:	16 inches (411 millimeters)
Stacker capacity	Short:	25 shallow-well plates
	Tall:	50 shallow-well plates

Liquid Capacity

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

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: *ControlMate* Software, version 1.06 or later

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

Table 2: PlateMate Plus Accuracy and Precision

Cat No. Pipet Head	No. of Channels	Volume Range	Accuracy	Precision
501-20004	96	0.5 - 30.0 µl	+/-2.0% or .15 µl	+/- 1.5% or .10 µl
501-20001*	96	5.0 - 300 µl	+/-2.0% or 1.0 µl	+/- 1.5% or .75 µl
501-20002	384	0.5 - 30.0 µl	+/-2.0% or .15 µl	+/- 2.0% or .1 µl
501-20005	384	1.0 - 100.0 µl	+/-2.0% or .5 µl	+/- 2.0% or .25 µl

* Catalog No. 501-20001 when used with 300µl Metal Probes (501-20007) allows for an expanded volume range of 1.0 - 300.0 µl).

2.5.3 Liquid Transfer Speed

The ***PlateMate Plus*** was tested against the original ***PlateMate*** instrument to compare liquid transfer speed. In both reagent addition and plate-to-plate transfers, the ***PlateMate Plus*** showed significant improvement. The results are summarized below.

Reagent Addition Protocol

- Reagents dispensed using automatic fill reagent reservoir
- Single aspiration of reagent with incremental dispensing to the entire plate.
- Plates stacked and unstacked one time

Table 3: PlateMate Plus vs PlateMate in Reagent Addition

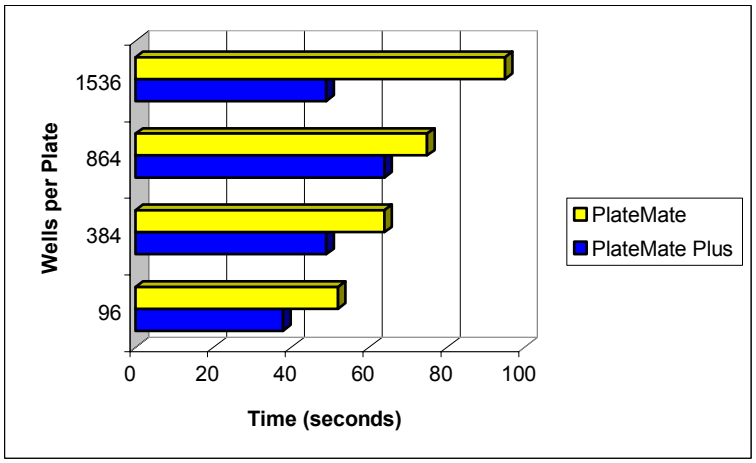


Table 3 compares the time (in seconds) that both instruments require to fill the specified wells using a 96-well pipettor head.

Table 4: PlateMate Plus Reagent Addition with 384-well Head

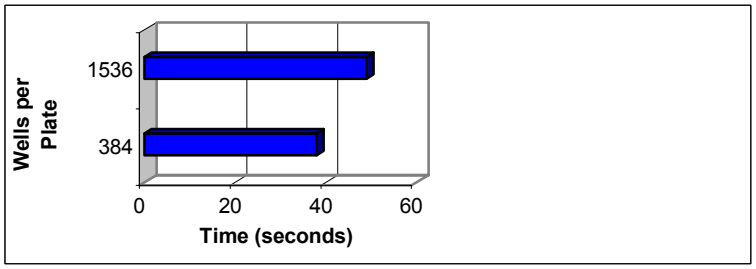


Table 4 shows ***PlateMate Plus*** reagent filling time for 384 and 1536 wells using a 384-well pipettor head.

Table 5: PlateMate Plus and PlateMate comparison (plates per hour)

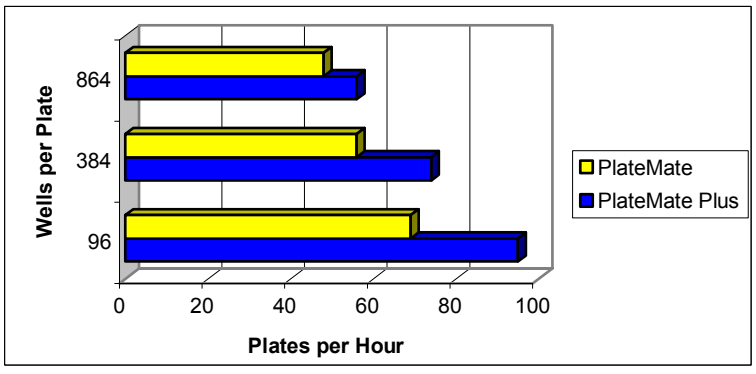


Table 5 compares the number of plates that both instruments can process in an hour.

Plate-to-Plate Transfer Protocol

- Plate-to-plate liquid transfer time, including plate stacking.
- Tip wash included between transfers using 3 wash cycles.
- All transfers are from 96-well plates to specified format.

Table 6: Plate-to-Plate Transfer with 96-well Head

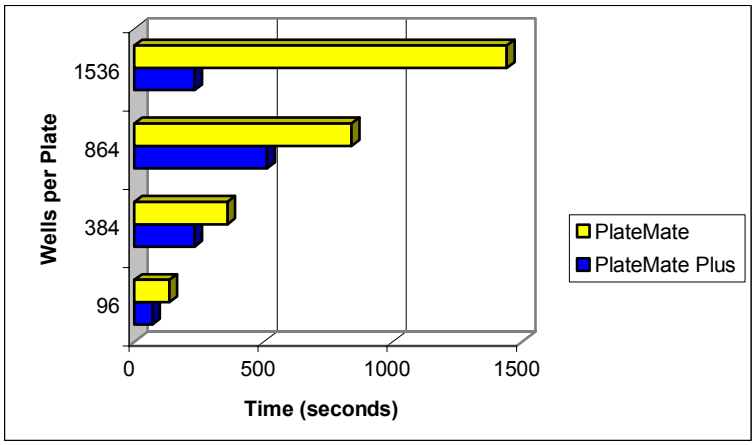


Table 6 compares the time (in seconds) that both instructments require to transfer liquid from one plate to the other.

Table 7: PlateMate Plus Plate-to-Plate Transfer (plates per hour)

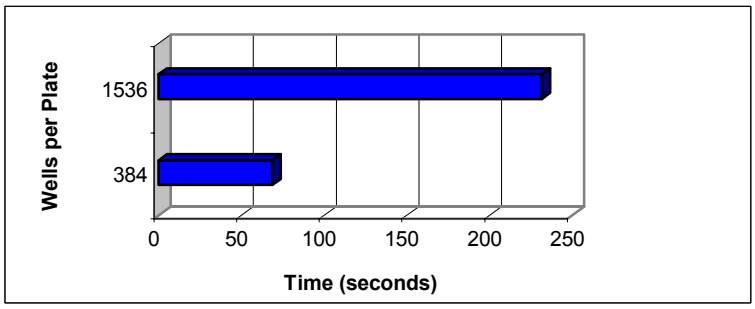


Table 7 shows plate-to-plate transfer time for the ***PlateMate Plus*** using a 384-well pipettor head.

Table 8: PlateMate Plate-to-Plate Transfer with 96-well Head

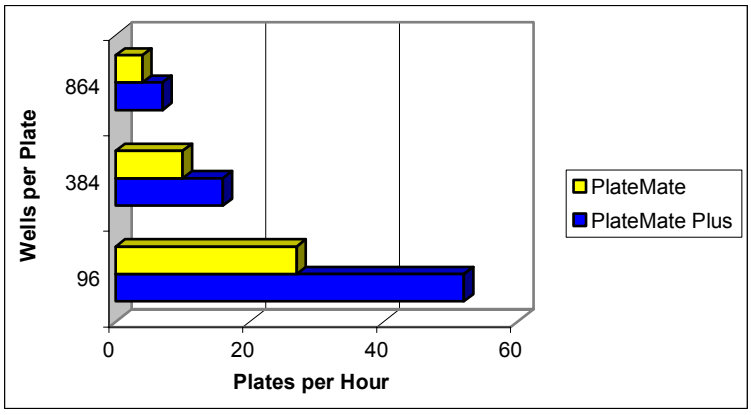


Table 8 compares the number of plate-to-plate transfers that both instruments can handle in an hour.

2.6 Hazards and Precautions

There are no known hazards associated with the ***PlateMate Plus*** 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.

WARNING! 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.

WARNING! 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.

WARNING! 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.

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 Matrix Technologies service personnel.

WARNING! 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.

WARNING! Keep hands away from moving parts (e.g., lifters in the ***PlateMate Plus*** and stacker, 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.

CAUTION! 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.

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

CAUTION! 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.

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.

CAUTION! 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.

CAUTION! Do not exert undue pressure on the slide rails.

CAUTION! Do not restrict movement of microplate carriage and lifter.

CAUTION! Never load an empty tips magazine, as this may damage the pistons.

CAUTION! Use only accessories and replacement parts provided by, or recommended by, Matrix Technologies. Use of improper accessories and parts can damage the instrument.

CAUTION! The following components contact liquid directly; therefore, use only liquids that are compatible with these components:

Polypropylene tips
PMMA or PTFE vessels
Silicone hoses

Use caution when handling acids, bases and organic solvents, they will reduce the life of the piston-gasket system. 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.

If you have questions about any aspect of operating the ***PlateMate Plus*** safely, please contact Matrix Technologies Corporation.

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 transfer to complex pipetting sequences.

Because the ***ControlMate*** software is tightly integrated with the ***PlateMate Plus*** instrumentation, you can control all ***PlateMate Plus*** 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 in1536 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 7, Maintenance and Service: 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
  - CD-ROM drive for installation
  - VGA or Super VGA video display card
  - Microsoft- or IBM PS/2-compatible mouse
- Computer interface requirements:
  - Serial RS-232C, 16 byte FIFO memory (UART16550AFN)
  - 9600 bps
  - 7 data bits
  - 1 stop bits
  - Even parity

Note: For details on computer interface connection, see *Section A.1, 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 ***PlateMate Plus***.

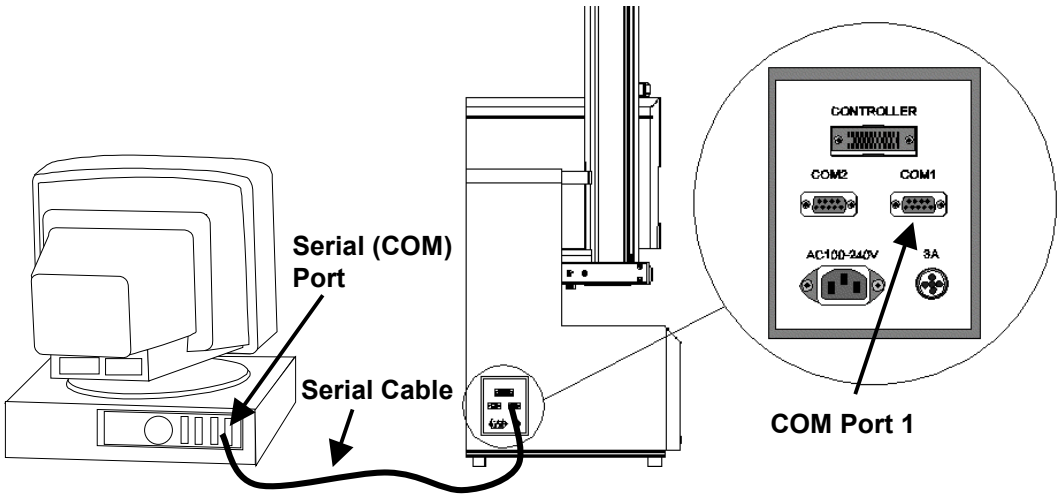


Figure 5: Computer Connection

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.

3.2.3 Starting *ControlMate*

Start ***ControlMate*** by clicking **Start** in the Windows Taskbar and selecting ***ControlMate*** from the Programs menu.

The following window appears:

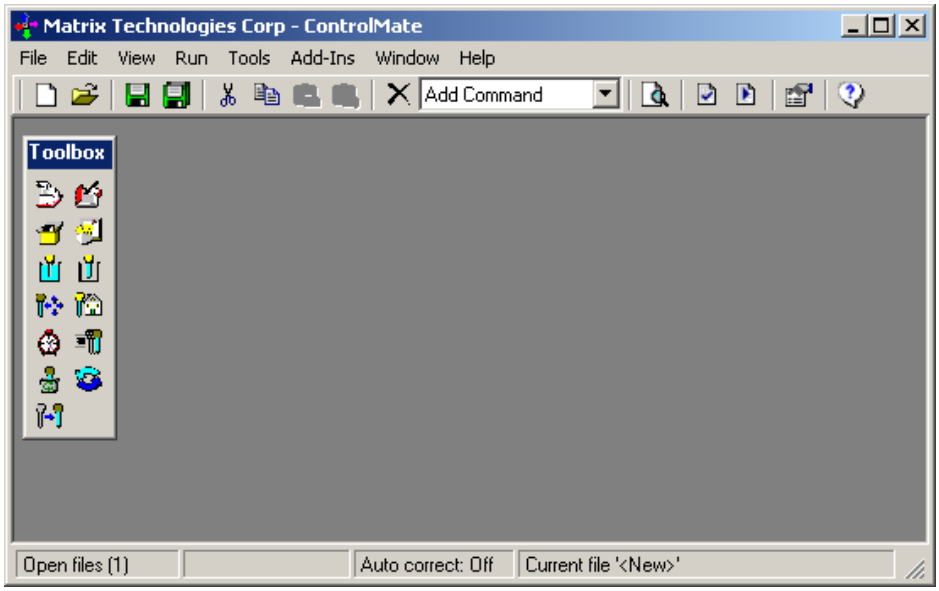


Figure 6: ControlMate Main Screen

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

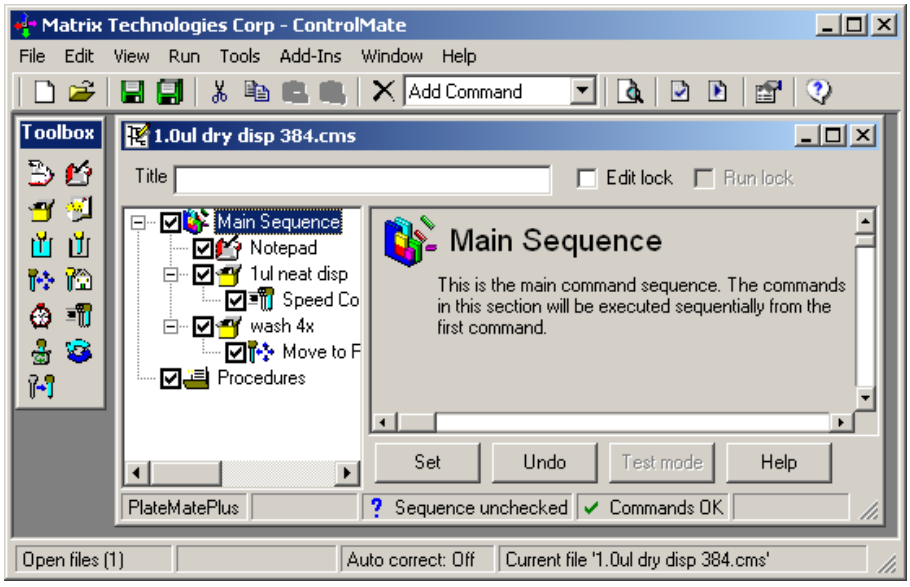


Figure 7: Main Screen with Child Dialog Window

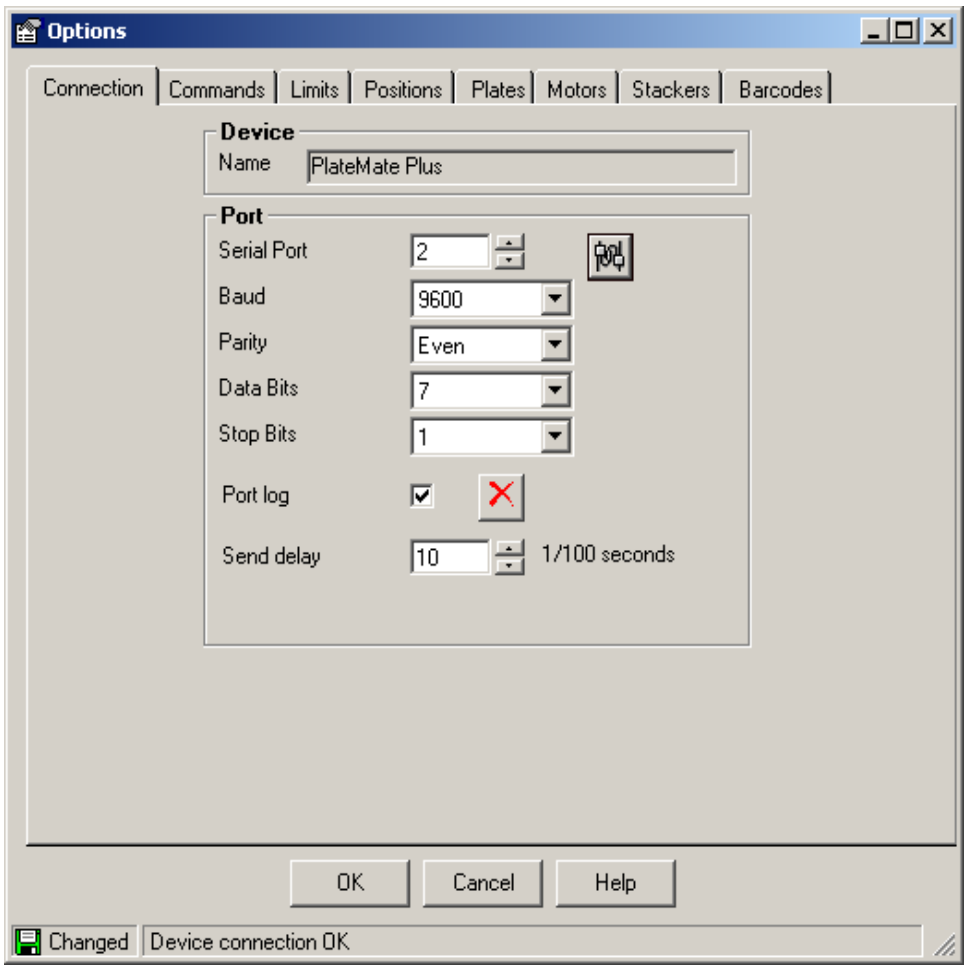
Before you begin creating pipetting programs, you must first configure ***ControlMate*** to work with your ***PlateMate Plus*** system. The next section describes the ***ControlMate*** configuration settings.

3.2.4 Configuring *ControlMate*

After installing and starting ***ControlMate***, configure the software for your ***PlateMate Plus*** system, using the **Tools>Options** command in the menu bar.

In the Tools Menu, select **Options**.

The computer configuration screen opens. The following Connection screen displays typical settings.



In the Connection screen:

a. Select an available serial port.

b. Change the baud rate, parity, data bits, and stop bits if they do not match the settings that are specified in Section 3.1, Minimum System Requirements.

c. Checkmark **Port log** to create a text file of all ASCII communication between the computer and the ***PlateMate Plus***.

The Port log file (.txt) resides in the ***ControlMate*** directory. This file is continuously amended. To clear the Port log file, click the **Delete** button  .

d. Indicate how many seconds the software should wait for a response from the ***PlateMate Plus*** (default is 10 seconds).

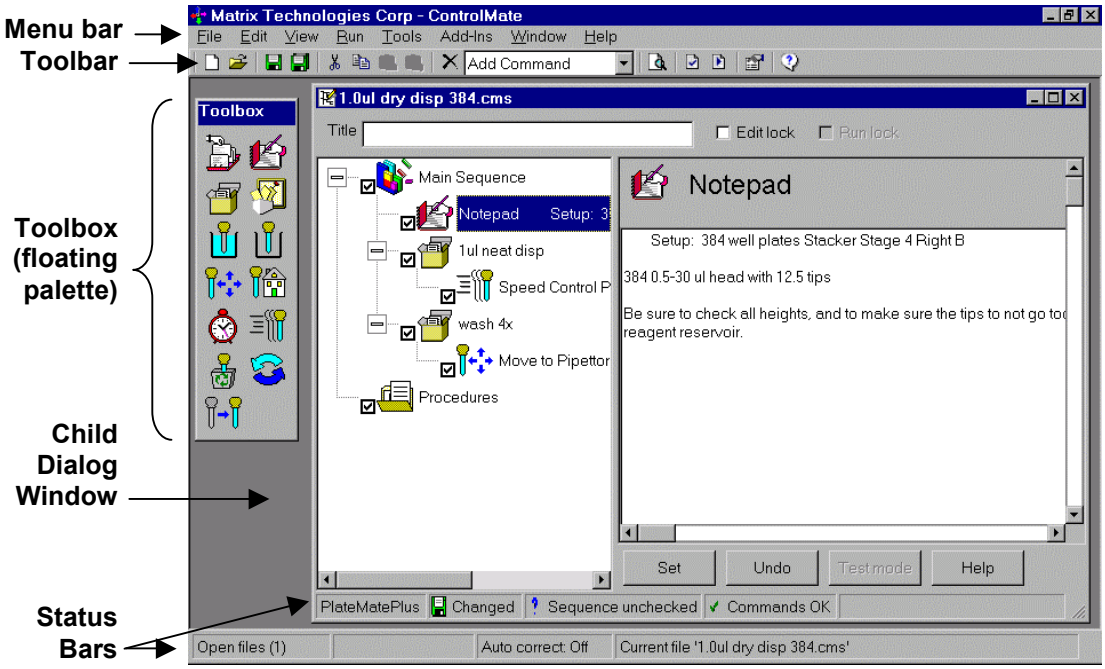
e. Click the **Test** button  to check the connection.

Enter any necessary changes to the other configuration screens, such as: pipetting size (head parameters), stacker (if installed), horizontal drive (if installed), and 384-well option. See the *ControlMate Reference* section on page 32.

f. Click **OK** to accept the changes and close the window.

3.2.5 The Main Application Window

The main application window provides function dialogs 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
	Views the clipboard contents

Toolbar Icons

 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 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

Module Commands

 **Aspirate:** Aspirates a measured volume. Should be preceded by a move command (see *PlateMate Plus Programming* Rules *on page 54*.)

 **Dispense:** Dispenses a measured volume or all of the liquid in the tips. Should be preceded by a move command (see *PlateMate Plus Programming* Rules *on page 54*.)

 **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.

Toolbox icons

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 (see *PlateMate Plus Programming* Rules *on page 54*.)

Change Tip Magazine: Pauses sequence file execution for tip magazine change. Provides step-by-step instructions to change tip magazine.

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.

3.2.6 Creating Pipetting Programs

ControlMate software includes a number of program 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.

Program creation starts with opening a new file window by selecting **New** in the **File** menu, or pressing the key combination CTRL+ N, or clicking the the **New Sequence** button . The list of program commands can be viewed and selected by clicking the **Add Command** drop-down menu Add Command. Special notes and explanations can be found in **Help** . After you complete the program, you can 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.

Using Online Help

If you need help using the ***Control*Mate** software program, you can 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** to display the help information.

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

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.

3.3 Software Reference

The following sections describe each software function in detail. This information can also be found in the online Help.

3.3.1 Command Groups

ControlMate contains two groups of commands. The command groups are:

- IntrinsicIDH_3001
- Module SpecificIDH_3002

Child Dialogs

Actions within ***ControlMate*** are presented as child dialogs. Each dialog has specific tasks. The child dialogs are:

- Options
- Sequence File Editor
- Toolbox
- Print Preview
- File Validation
- File Execution
- Clipboard Viewer
- Edit and Run Locks
- Password Validation

Intrinsic Commands

The intrinsic commands are specific to ***ControlMate***™ rather than to a module. The commands are normally associated with the control of program flow and annotation.

The intrinsic commands are:

- Main Sequence
- Procedure Collection
- Procedure Call-outIDH_8001
- Command Group
- NotepadIDH_8004
- Procedure

3.3.2 Sequence File Editor

Overview

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

The dialog contains a number of frames:

File Header: The file header contains the fields 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 that relates to the sequence file that is currently open.

Sequence File Editor: Header

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

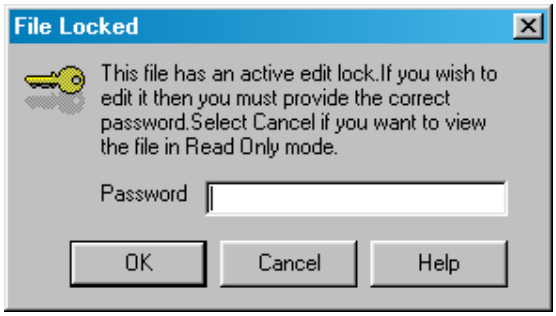
Fields:

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. Check this field to display the Edit Lock dialog window.

Run Lock: Used to set a password on the file to control access for execution. Check this field to display the Run Lock dialog window.

Edit and Run Locks



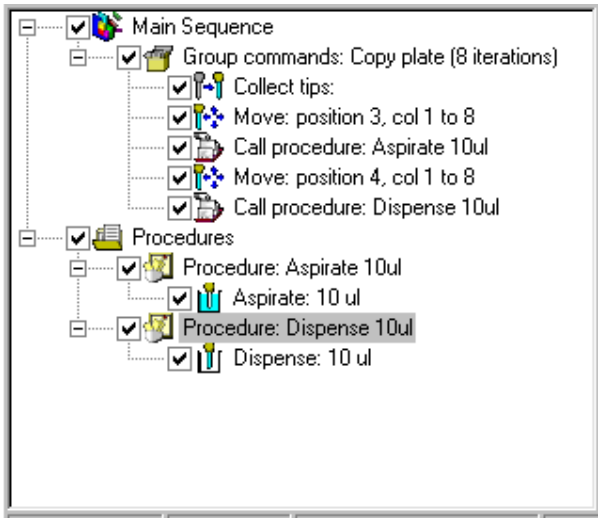
The edit and run lock dialogs are used to control access to sequence file editing and execution on a file-level basis. Once a lock has been set, the correct password is required to enable access to all file functions. This means that it is possible to create sequence files and then set an edit lock to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

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

Note: Passwords are case sensitive.

Sequence File Editor: 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 dialog 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: You can delete existing commands from the command structure by highlighting the command, then either pressing the *Delete* key on the keyboard or clicking the delete icon ✕ on the main application toolbar.

Moving a command: You can move commands to a new position in the sequence structure by using the “drag-and-drop” method. To move a command, highlight the command icon and hold the left mouse button pressed while dragging the command icon to the new position. Release the mouse button when the command is in place. New commands are placed below the previous command.

Alternatively, you can use the Cut, Copy, and Paste buttons 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 causes 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, all child commands will follow the same action as their parent.

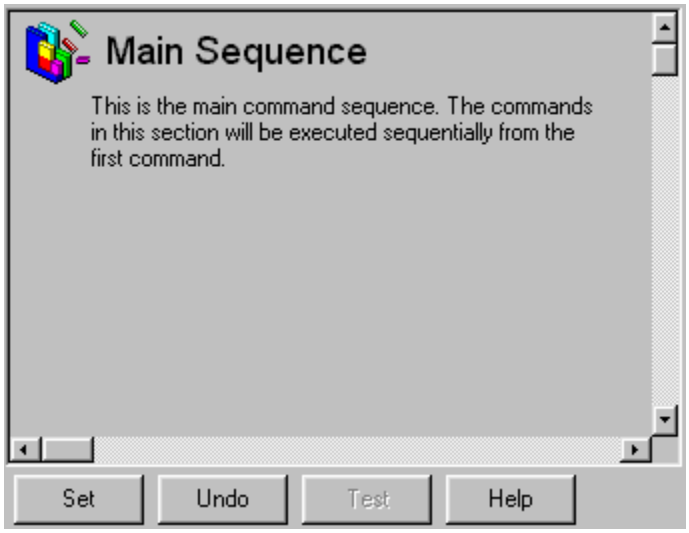
***Cut*:** To cut a command, highlight it, then click this button on the toolbar.

***Copy*:** To copy a command to the clipboard, highlight it, then click this button on the toolbar.

***Paste*:** To paste a command from the clipboard into the command tree, highlight the command after which the new command is to be pasted, then click this button on the toolbar.

Sequence File Editor: 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 dialog) 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.

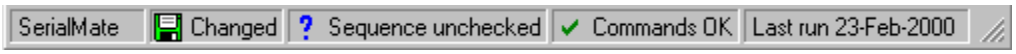
***Undo*:** This will change the settings back to the original values prior to the current edit.

***Test*:** This allows the values for the command to be tested on the device. This is useful, for example, for testing heights and positions.

***Help*:** Displays help for the respective command.

Sequence File Editor: Status Bar

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



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 throughout the sequence. Sequence validation is carried out via File Validation or File Execution.

Command Validation: This provides status on the validation of individual commands, for example, if an incorrect height value is 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, go to the command tree and highlight the command after which the new command is to be added. Click the icon of the command required. If the command is added in an incorrect position, you can move it to the required location within the command tree.

Print Preview

The print preview dialog 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 next 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.

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 dialog window.

***Show*:** Jumps to the highlighted command in the sequence file editor window.

***Help*:** This help page.

Clipboard Viewer

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

Password Validation

Sequence files that have an edit or run lock set will cause this dialog box to be displayed whenever the file is opened within the sequence file editor (if edit lock is set) or file execution (if run lock set). The dialog 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. In the case of a run lock, the file cannot be executed on the device.

3.3.3 Procedure Collection

The procedure section contains all of the procedures that exist within the current sequence file. The procedure section is not executed during file execution. Procedures contained within this section can be called either from within the current file main sequence structure (internal call) or from another file (external call).

Call Procedure

The call procedure command allows the inclusion of a selected procedure within the main sequence file. This allows for the creation of standard procedures. For example, commands for aspirating or dispensing an entire plate could be called from other programs without having to redefine the parameters. This reduces the time needed to create sequence files.

The call procedure command allows procedures to be included either from the library of procedures within the current sequence file or from another sequence file.

Fields:

***In this file*:** Populates the *Sub Routine* field with the procedures that are in the current sequence file.

***In a different file*:** Populates the *Sub Routine* field with procedures from another sequence file.

***File*:** Displays the selected filename (if calling a procedure from a different file).

***Path*:** Displays the file path (if calling a procedure from a different file).

***Sub Routine*:** Allows the selection of a sub routine to be called.

Command Buttons:

***Select*:** Causes the sequence file selection dialog to be displayed to allow selection of a sequence file that contains the procedure to be called.

Notepad

The notepad is used to create a note entry within the sequence file. This is useful for documenting the reason for command values, positioning, and for future reminders of device configurations for specific sequence files, and so on. The content of the notepad has no effect on the sequence file during file execution.

Procedure

A procedure contains a group of commands that are executed whenever the procedure is called from a main sequence structure. The call can be made from the current sequence file (internal call) or from another sequence file (external call). During file execution, any commands contained within a called procedure will be executed as if they existed within the main program structure.

This allows for the creation of standard procedures. For example, commands for aspirating or dispensing an entire plate could be called from other files without having to redefine the parameters. This reduces the time needed to create sequence files.

Fields:

Name: A text field that can be used to represent the name of the procedure. If the text entered is the same as another in the procedure collection, an index value is appended to the text.

Main Sequence

The main sequence represents the main command sequence. It is called once during file execution and is processed from the top down. You must select the main sequence checkbox in the command tree in order to execute the entire file.

Group Commands

A command group represents a collection of commands. This is useful when you create sequence files because you can structure commands based on their use. For example, a group command can represent the copying of samples from a block or the dilution of a block.

Fields:

***Title*:** Allows the entry of a text value that represents a name for the group.

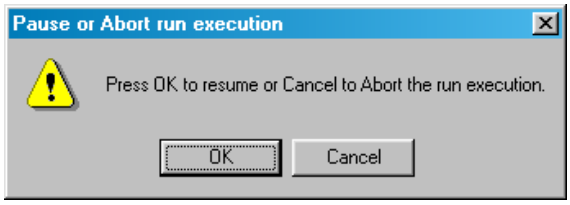
***Loop*:** Allows the setting of a value that represents the number of iterations that the group is to be processed. Command execution will proceed to the command following the group once the loop has been processed the number of times specified by this value.

Sequence File

This file contains the sequence of commands as created in the Sequence File Editor dialog box.

Pause or Abort File Execution

When you click the Stop button on the File Execution, the following dialog is displayed:



Command Buttons:

***OK*:** Continues file execution.

***Cancel*:** Aborts file execution.

Configuration File

This file exists in the application directory on the disk. It contains all of the default parameters required to start the application, rules, and default values for the command fields and for any device settings.

Contact your Matrix Service Representative, if you want to change any of these default settings. Failure to do so may affect your warranty.

3.3.4 Options

Options Overview

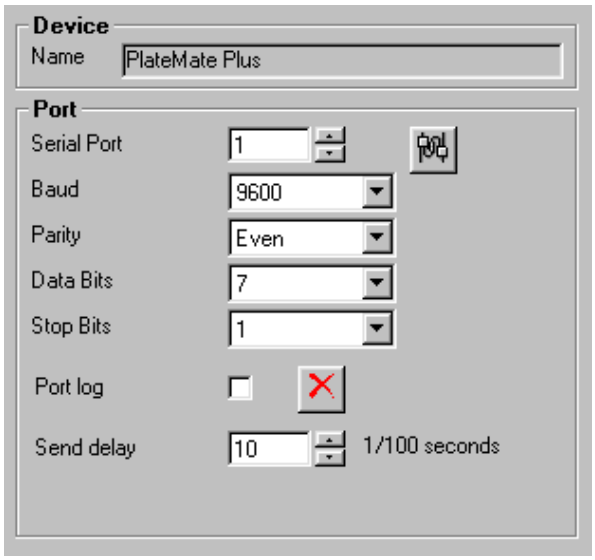
The Options dialogue is used to set the default parameters for a number of options within the ***ControlMate*** application. The Options dialogue is found in the Tools menu or by pressing  on the main application toolbar.

The options are grouped into a number of sections.

- **Connection**: To set default parameters for serial communication with the device.
- **Command Defaults**: To set the default field values for the module specific commands.
- **Limits:** To set the range limit values for the fields within the module specific commands.
- **Positions**: 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.
- **Stackers**: To update and set parameters relating to stacker related positions.
- **Barcodes**: To set the parameters used for retrieving and storing barcode data.

Options: Connection

The ***PlateMate Plus*** 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.
- *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 ***PlateMate Plus*** 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.
- *Port 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 

- *Send Delay*: Use this to change the delay between commands issued to the ***PlateMate Plus*** 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.

Command Buttons

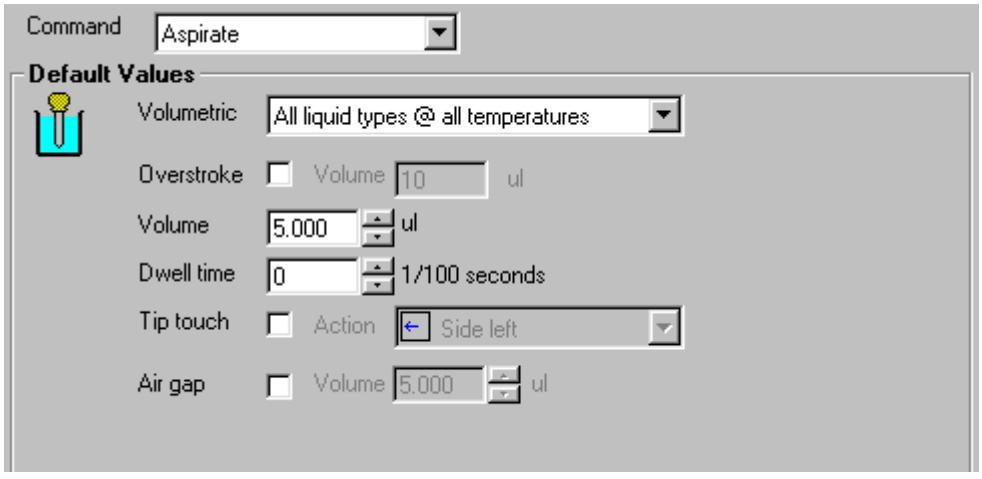
 (Test connection)*:* Clicking on this button will communicate with the device by issuing a reset command. You must ensure that :

- 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 the port log file): This action will remove all actions form the port log file.

Options: 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.



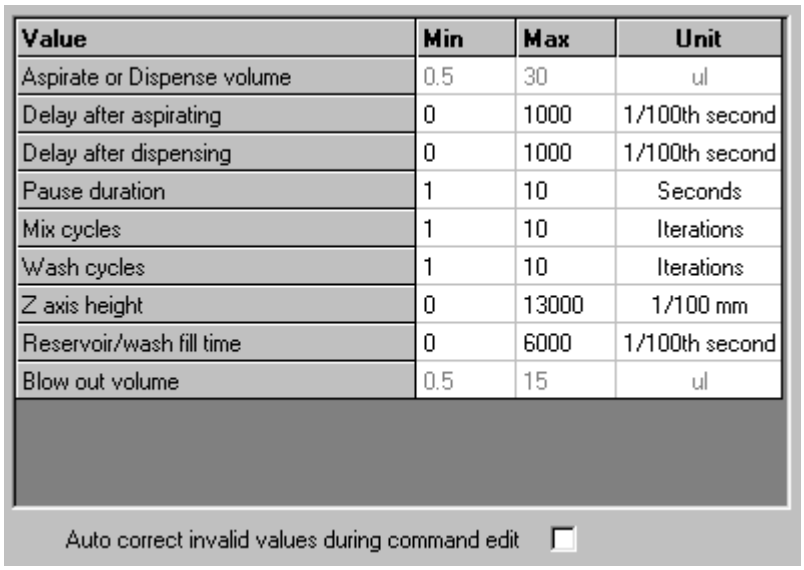
Fields

- *Command*: This drop down box allows the selection of available module specific commands.

Options: 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	10	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	15	ul

Auto correct invalid values during command edit ☐

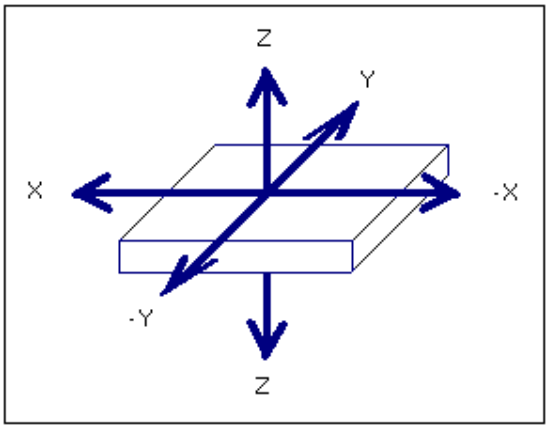
Fields

- *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.

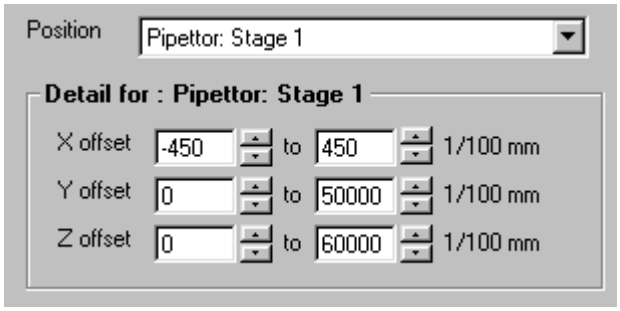
The main application window displays the current status of this field on the status bar at the foot of the window.

Options: 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. 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.



Fields

- *Position:* The required stage position.
- *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

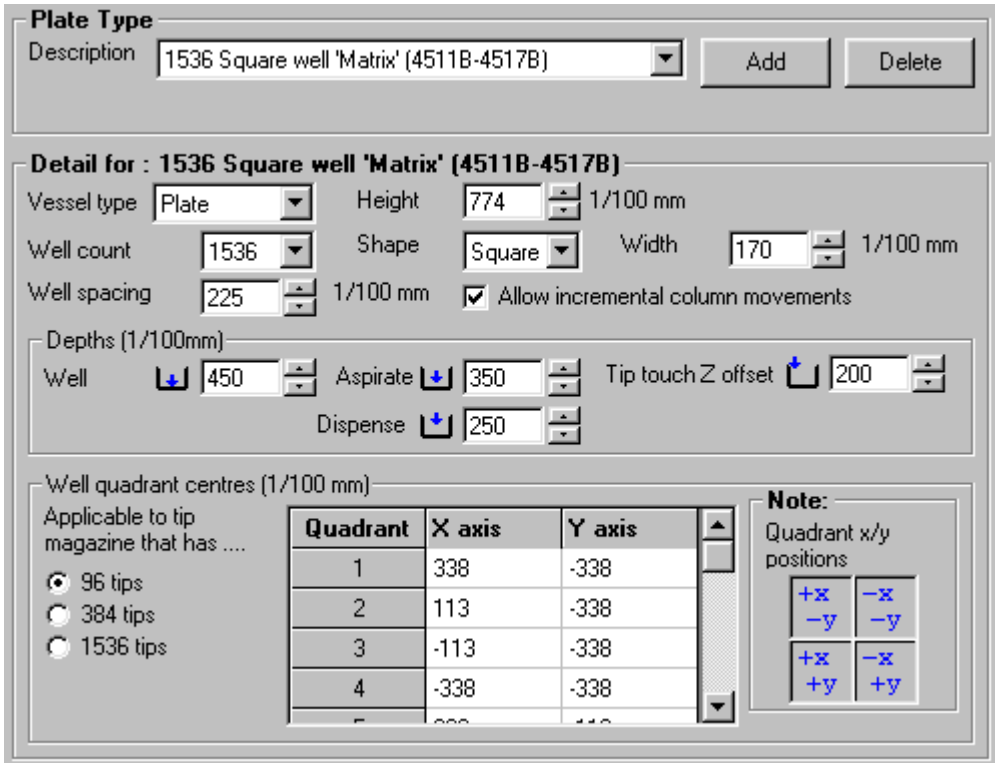
Options: Plates

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.

IMPORTANT: 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

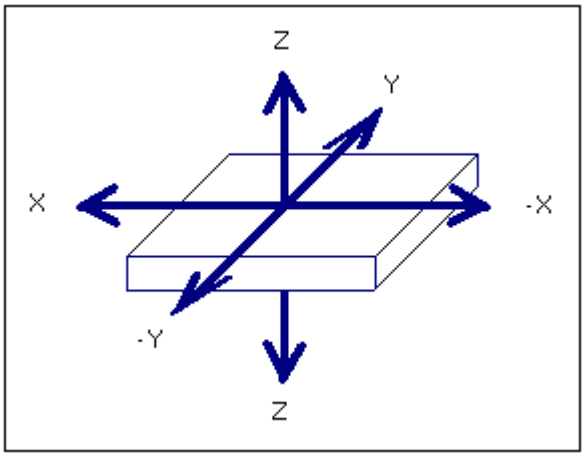


Fields

- *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, for example, 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 (e.g., 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.

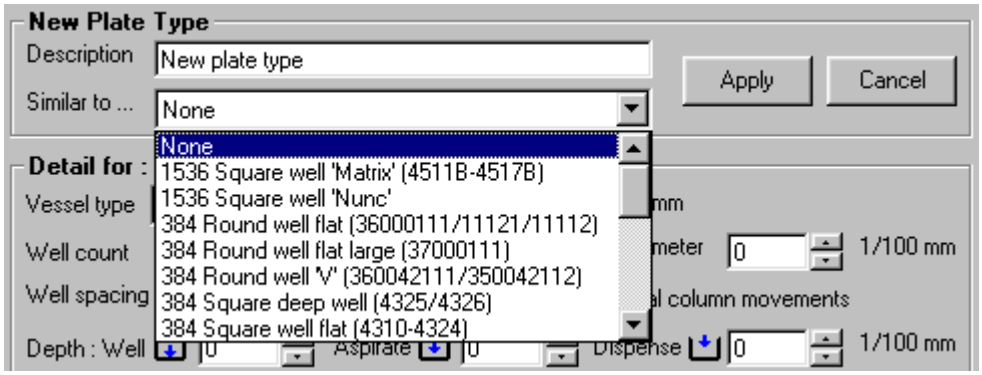
For example, setting the radio button to 96 tips for a 384 well plate would display a grid containing 4 quadrants.

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 a 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.

Options: 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.

Note: 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.

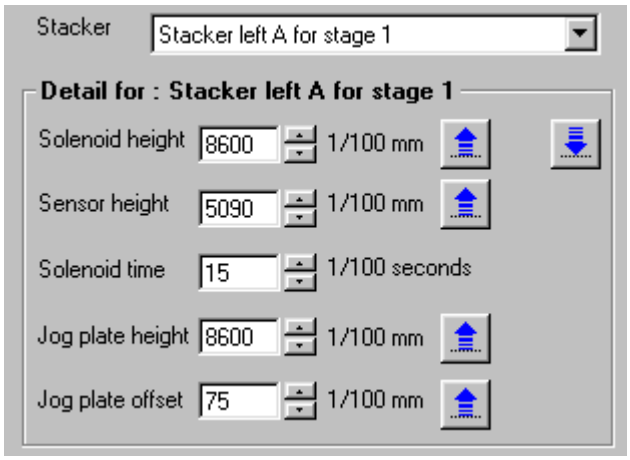
(The default settings are shown above)

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.

Options: Stackers

It is possible to set the various heights and offsets for positioning of plates at each stacker. The fields allow for a number of values to be set and is useful for fine tuning the retrieval or return of plates for each stacker position. The stacker positions relate to the accessibility of each stage to each stacker chimney. The settings entered in this dialogue are used within the Move command for stacker control. It is possible to test each value to assist in checking the accuracy of each setting.



Fields

- *Stacker:* Used to select the stacker position for which changes are to be made.
- *Solenoid height:* This defines the height at which the stage is to be lifted before the solenoid can be activated. In use this height is used in conjunction with the plate height and ensures that the plates in a stack are not 'dropped' onto the stage. Therefore it is important that the height is measured accurately, by using the test height button  and aiming to get the top surface of the stage approximately 2mm below the top surface of the solenoid being tested. This will compensate for the differences in the lip height on the base of different plate types.

  Note: It is not necessary to use a plate to test this height since it is based on using the top surface of the stage adapter for a specific stage position.

- *Sensor height:* Use this field to set the height at which the empty stage would be raised to position a plate in front of the stacker optical sensor. The stacker sensor is used within the **Move** command to determine stacking success. Again the height is to be measured by positioning the top surface of the respective stage just below the sensor so that it is positioned as near to the sensor unit as possible without actually triggering it. If the LED is activated (switches from glowing red to green) then the stage has been lifted too high.

- *Solenoid time:* This field determines the length of time by which the respective sensor is to be activated. Too long a time and the sensor may overheat, too short a time and the plates may hit the sensor during retrieval or return. The recommended solenoid time is 15 milliseconds.
- *Jog plate height:* Use this field to set the height at which the stage motor will move backwards and forwards to try to release plates which stuck to one another in the chimney.
- *Jog plate offset:* This is used in conjunction with the jog plate height and is used to determine how much movement backwards and forwards the jog action uses.

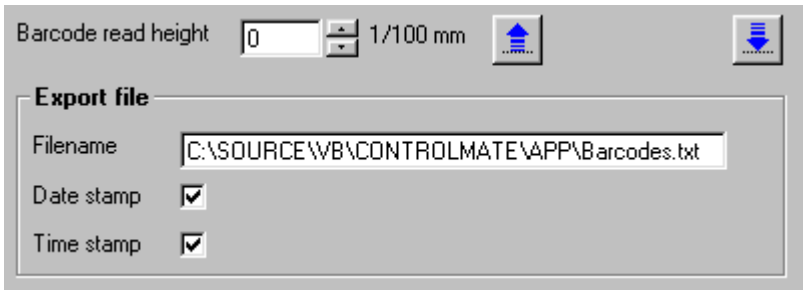
Command Buttons

-  (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.

Options: 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



Fields

- *Barcode read height:* Use this field to set the height at which the stage is to be raised in order for the reader to read the barcode.  can be used to test the height.
- *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.

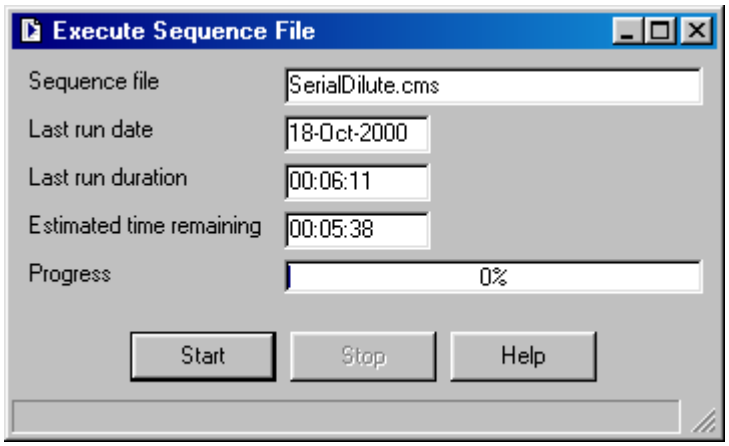
- *Date stamp:* If checked then the current system date will be written along with the barcode data for each successful barcode read.
- *Time stamp*: If checked then the current system time will be written along with the barcode data for each successful barcode read.

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.

3.3.5 File Execution

The File Execution dialogue controls the ***PlateMate Plus*** 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.

3.3.6 Module Specific Commands

The module specific commands for the ***PlateMate Plus*** 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

The following Add-In modules are also available:

- Change Pipettor or Tips
- Volumetric Calibration

PlateMate Plus Programming Rules

There are a few simple steps to follow when creating sequence files for the ***PlateMate Plus*** 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.

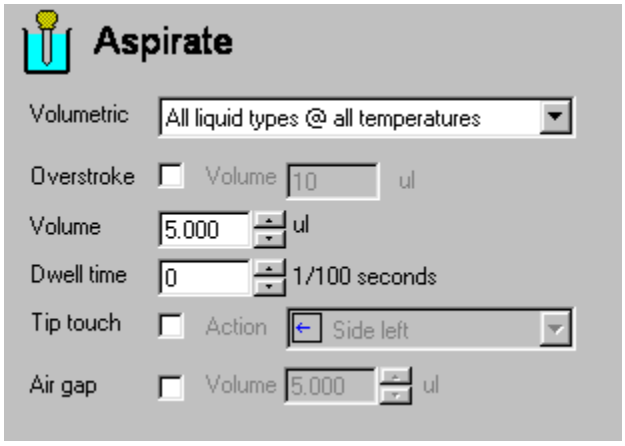
Aspirate Command

Aspirates a 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 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 dispenses. 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.



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. The default setting is optimized for pipetting water at room temperature.
- *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 volume throughout all 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 at the chosen vessels well top plus the Z offset, the height of which is determined via the Tip Touch Z offset value in Tools – Options – Plates.

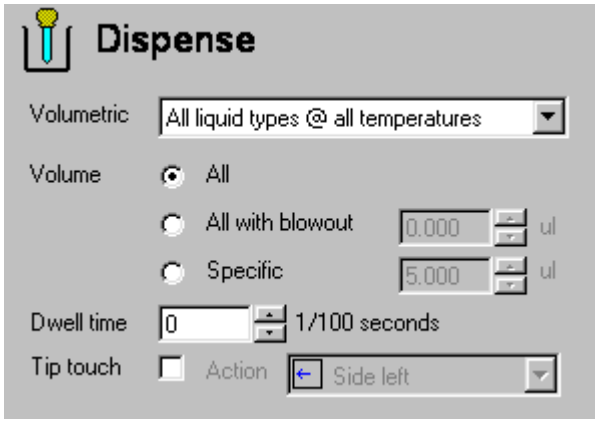
- *Post air gap*: This introduces an air gap at the end of the tip to ensure that sample does not leak during stage movement.

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.

> **IMPORTANT:** 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 where the piston will return to it's 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**.**

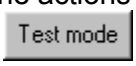
  The increment and decrement buttons will change the volume value accordingly. The increment for these actions can be set via the Change Pipettor or Tips Add-In
- *Dwell Time*: The dwell time is used to specify a period of time over which to leave the tips in the sample immediately after the dispense 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 at the chosen vessels well top plus the Z offset, the height of which is determined via the Tip Touch Z offset value in Tools – Options – Plates.

Move Command

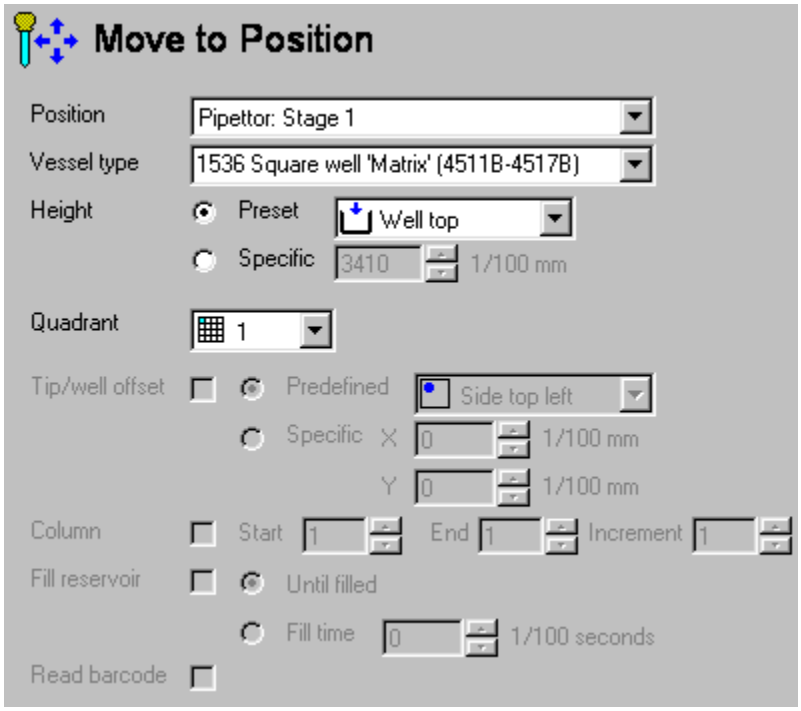
This command is used to position anyone of the stages at a preset position on the device. The stages are identified by the position number with stage 1 being the left most (as viewed from the front of the device) to stage 4 being the right most stage. The movements are grouped into three position types:

- Position a stage under the pipetting head
- Position a stage under a stacker for plate retrieval or return
- Position a stage at a stacker position where the stacker base and chimney unit has been removed. This allows for the vessel to be positioned in a place for external access for example when using external plate gripping devices.

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 

within the Sequence File Editor dialogue window.

Movements to position for pipetting

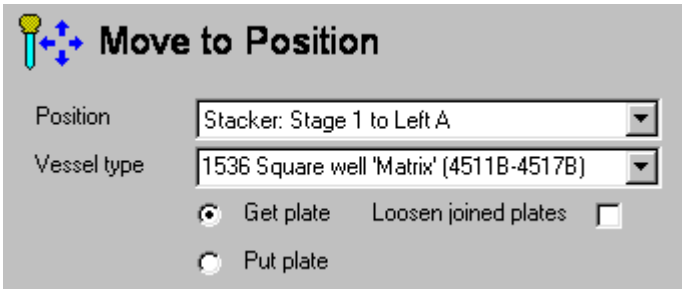


Fields

- *Position*: Sets the stage position. Other field parameter availability is dependent on the position selected, for example Selecting a stacker position will only show fields applicable for stacker control.
- *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 stage should be raised. 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 at the base of the stage from it's 'zero' position upwards.
- *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 across a plate. Once checked the 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.
- *Increment:* This is used to set the column increment value. A value of 1 will cause the stage to move to each well of the selected vessel.
- *Fill reservoir:* This field will be made available if the vessel type is defined as either a Tip Wash or a Reservoir. Once checked the options to either fill the vessel until the vessel's liquid level sensors report that the unit is full or for a fixed length of time are made available. If the option to fill for a fixed length of time then the time value is required.
- *Read barcode:* If the vessel type is one of PLATE and the preset height is Barcode Height then this field will be made available.

3.3.7 Movements for stacker control



Selecting a position which is based around stacker control will show a different set of fields specifically related to the control of plate retrieval and return. The parameters used for stacker control (e.g., heights, etc.) are taken from the Options: Stackers window dialogue.

Fields

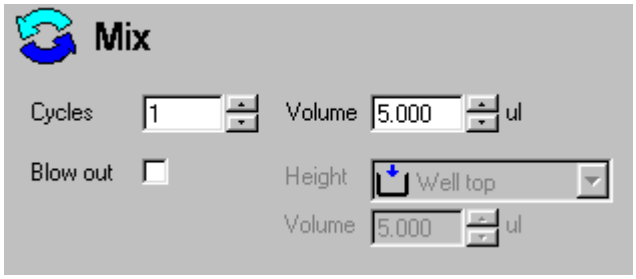
- *Position*: Sets the stage position. Other field parameter availability is dependent on the position selected, for example Selecting a stacker position will only show fields applicable for stacker control.
- *Vessel type*: Specifies the vessel type which is situated at the target location. Different vessel types have different settings for the other fields within this command. The values for this drop down list a created via the Options : Plates window dialogue.
- *Get plate*: Controls the actions required for retrieving a plate from the specified stacker position. This will then enable the loosen joined plates field which if checked will provide a forward and backwards movement to attempt to remove the adhesion between plates in the stack.
- *Put plate:* This will provide the actions necessary for returning a plate to the specified stacker position.

Mix Command

The Mix command aspirates and dispenses liquid in a vessel to create a homogenous or equally suspended solution.

This command also equalizes vapor pressure within the pipet tips to ensure accurate volume delivery. 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.

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 the stage position. It is therefore advisable to position a vessel (such as a wash station) under the tips before executing this command.

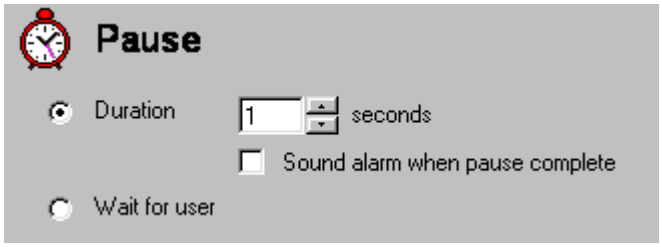
- *Piston*: Resets the piston motor.
- *Stage 1/Stage 2/Stage 3/Stage 4:* Checking any of these fields will reset the X, Y and Z axis respectively for each stage position.

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.

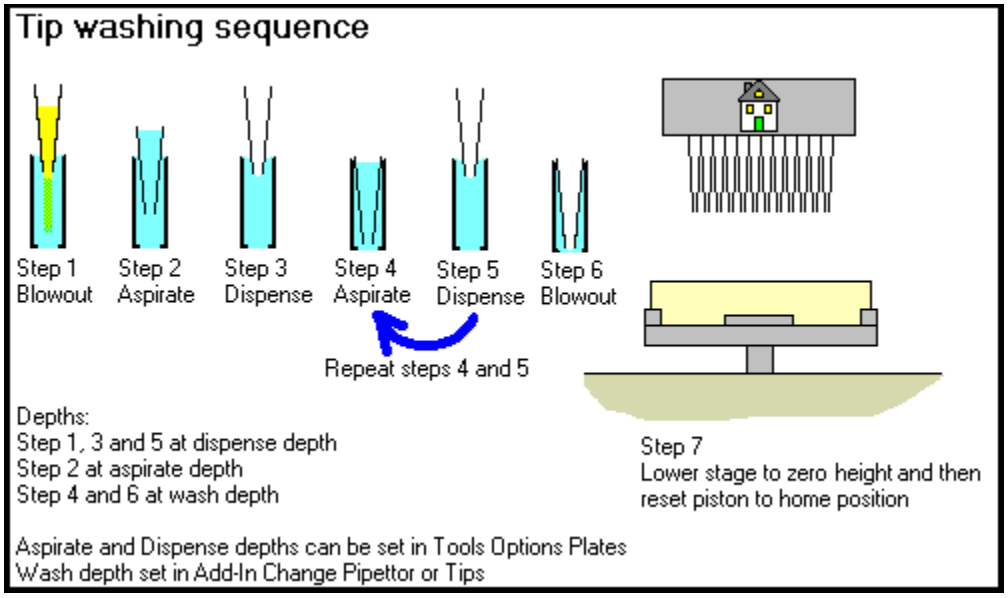


Fields

- *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 requires a preceding Move 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.
- *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
- *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 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.

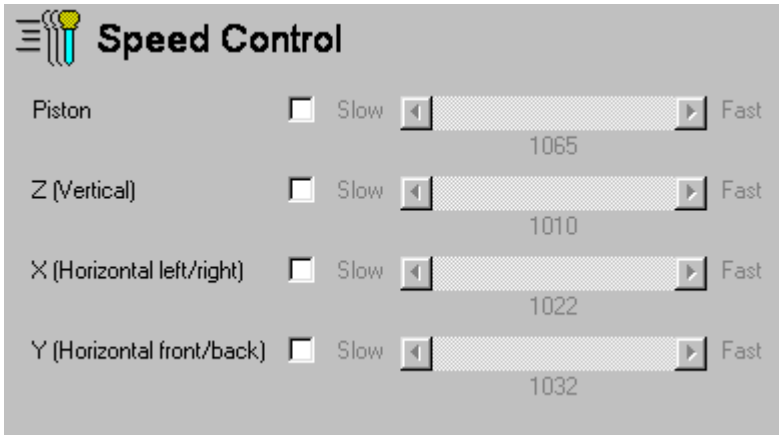
Changing the tip magazine will either display a series of window dialogue prompts on the screen (see above) or simply wait for the magazine change sequence to complete. Either way, the routine is based on the tip magazine sensor (limit switch) status at different steps within the change sequence to indicate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

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.

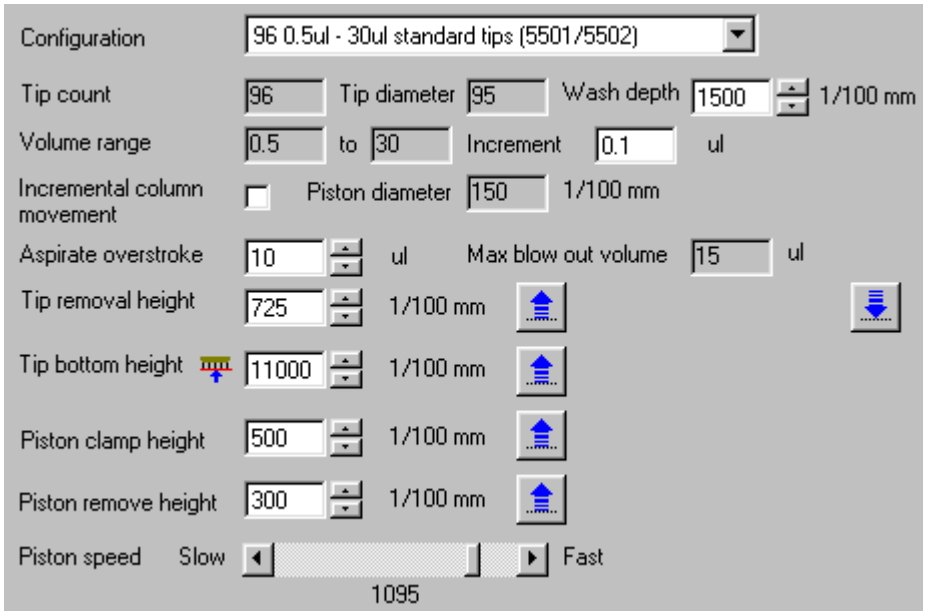
Add-In: Change Pipettor or Tips

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

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  .



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

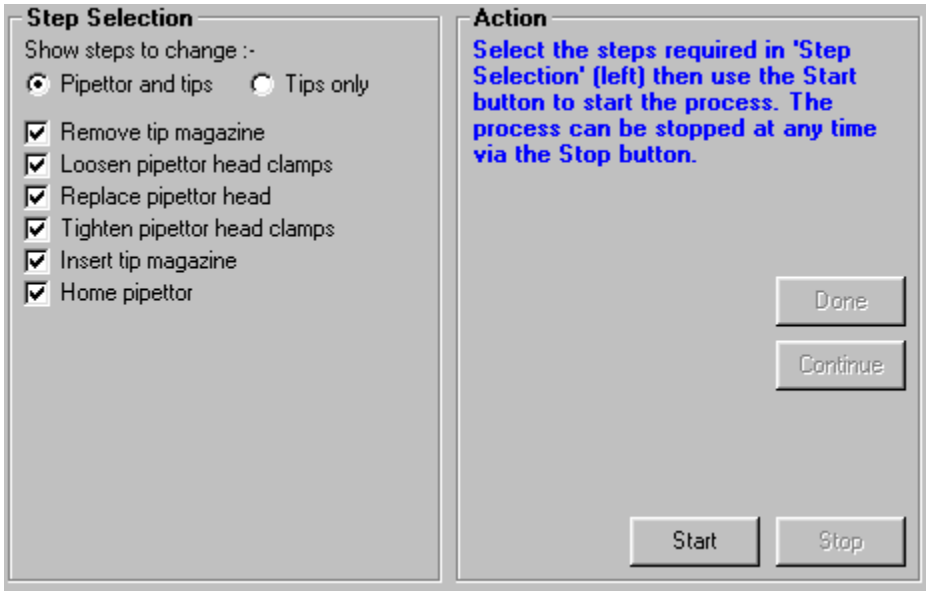
Command Buttons

-  (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.

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 plates and stages to crash into the tips and will result in improper volume accuracy.



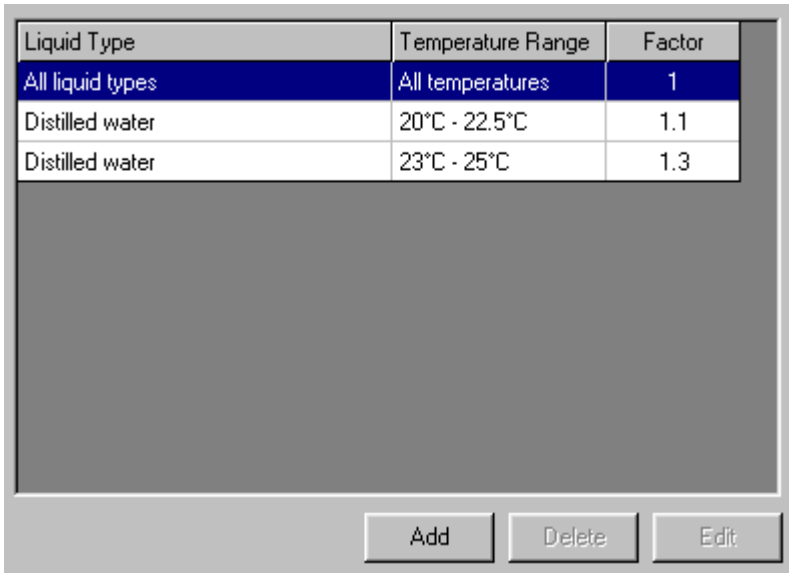
To start the process, select which option is required (change pipettor and or tips to change tip magazine only), then follow the prompts in the *Action* frame. If any errors occur or a step is not successful completed then the status or follow on action will also be displayed in the *Action* frame.

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.

Add-In : 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.

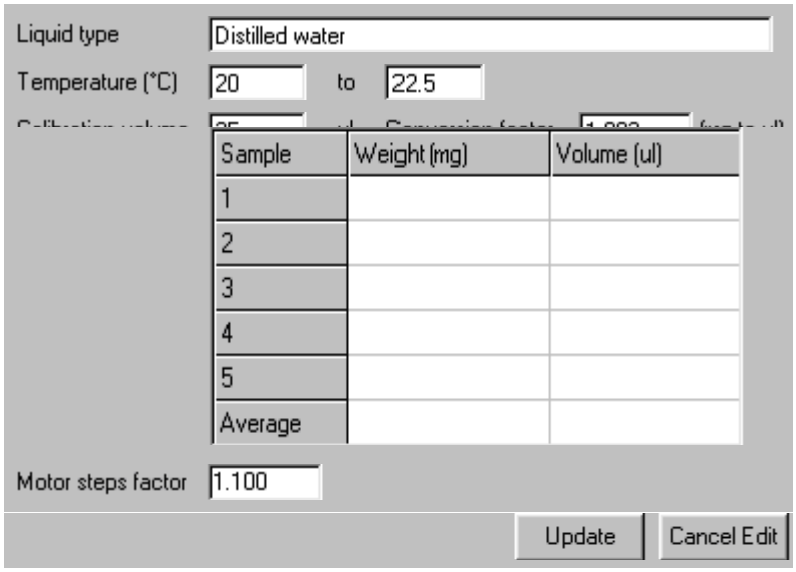
The factors are generated by using a standard volumetric correction factor for the specific liquid type at the temperature range required and to use this applied to the gravimetric measurement taken for the required volume. The net result will be the factor that will be used to correct the piston motor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



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 button to amend an entry either double click it or highlight it and select the edit button.

Measurements

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



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 (e.g., sea level 14.7 bar).

  Note: For aqueous-based fluids, this conversion factor is 1.0033 at room temperature

- *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.

Serial Communication (RS232)

RS-232C is a long-established standard ("C" is the current version) that describes the physical interface and protocol for relatively low-speed serial data communication between computers and related devices. It was defined by an industry trade group, the Electronic Industries Association (EIA), originally for teletype devices.

RS-232C is the interface that your computer uses to talk to and exchange data with your modem and other serial devices. Somewhere in your PC, typically on a UART chip on your motherboard, the data from your computer is transmitted to an internal or external modem (or other serial device) from its Data Terminal Equipment (DTE) interface. Since data in your computer flows along parallel circuits, and serial devices can handle only one bit at a time, the UART chip converts the groups of bits in parallel to a serial stream of bits. As your PC's DTE agent, it also communicates with the modem or other serial device, which, in accordance with the RS-232C standard, has a complementary interface, called the Data Communications Equipment (DCE) interface.

4 System Operation

The ***PlateMate Plus*** 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 in the sequence that they should be performed.

4.1 Introduction

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. Set up ***ControlMate*** (see *Chapter 3*)
   a. Start computer
   b. Start ***ControlMate***
   c. Create a new program
2. Set up ***PlateMate Plus***

   If your system is not set up to run the program you selected, use one or more of the following procedures:

   - Change microplate adapter (see Section 4.2.2)
   - Attach stackers (see Section 4.2.3)
   - Load microplates (see Section 4.2.4)
   - Attach Reagent Reservoir (see Section 4.2.7)
   - Attach Tip Wash Station (see Section 4.2.8)
   - Add ancillaries (buffer, water, reagent)

   The following procedures are software-controlled and require both the ***PlateMate Plus*** and ***ControlMate*** software to be running:

   - Change pipettor head (see Section 4.2.5)
   - Change pipet tips (see Section 4.2.6)

3. Run pipetting program (see Section 4.3)

Each task 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 ***PlateMate Plus***, review all of the sections to better understand when you would use each procedure.

4.2 Setting Up *PlateMate Plus*

The procedures you use in this section depend on the current setup of your ***PlateMate Plus*** instrument and how closely it matches your pipetting program.

To avoid instrument damage and ensure optimal performance of your pipetting program, use the microplate adapter, pipettor head, and pipet tips that are appropriate for the program and accessories to be used. All instrument setup procedures are described in this section.

4.2.1 Using Platform Stages

The ***PlateMate Plus*** comes with four platform stages that can accommodate different container types that are used in the pipetting operations, such as deep-well or shallow-well microplates.

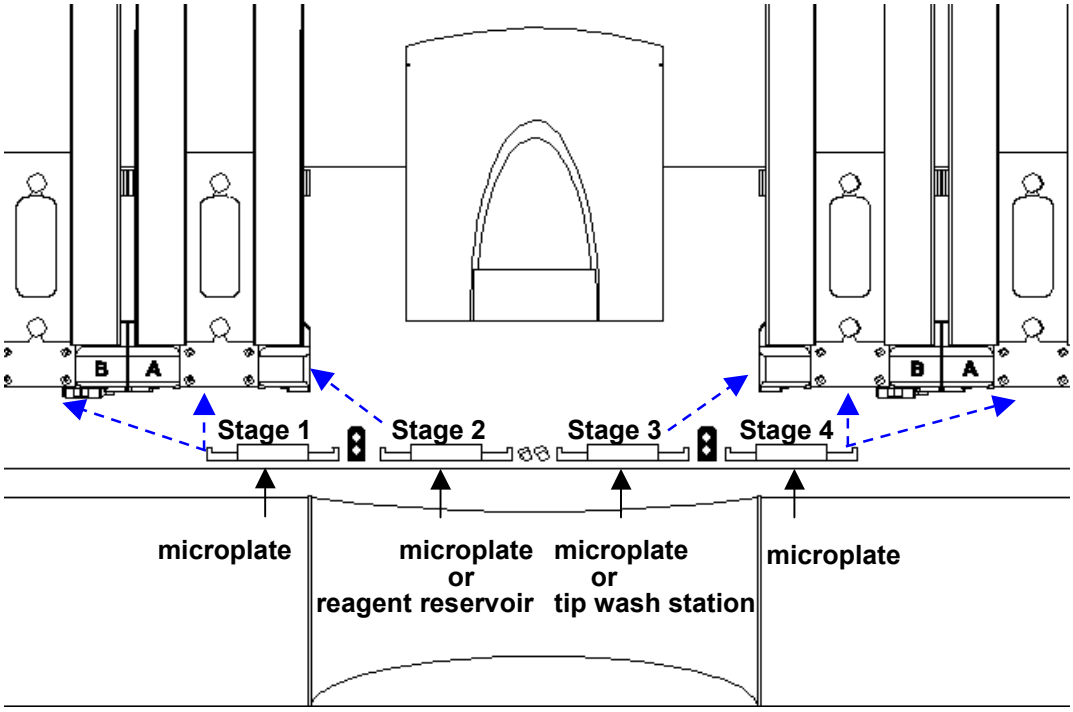


Figure 8: Platform Stages

You can use all four stages to transfer microplates or reserve stages 2 and 3 for the reagent reservoir and tip wash station, respectively. Stages are assigned to specific stackers, as follows:

Stage 1 = Left stackers, A and B

Stage 2 = Left stacker, A only

Stage 3 = Right stacker, B only

Stage 4 = Right stackers, A and B

Each stage is controlled by its own stepper motor, which enables the stage to be moved both vertically and horizontally to accomplish a pipetting operation, such as serial dilutions.

Four plate adapters come with the base unit to ensure a secure fit with the different plate types. Custom plate adapters, like those shown below can be purchased from Matrix Technologies.

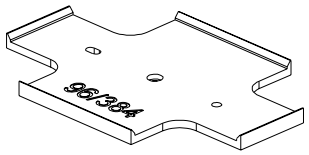


Figure 9: Genetix 96 or 384-well Microplates

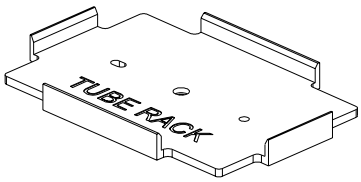


Figure 10: Matrix Tube Rack

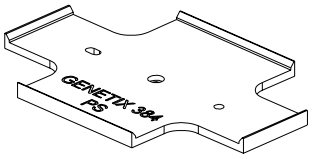


Figure 11: Genetix 384 PS Microplates

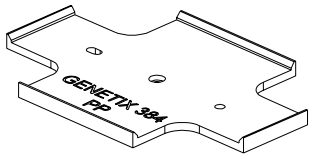


Figure 12: Genetix 384 PP Microplates

The 1536-well adapters can be purchased separately:

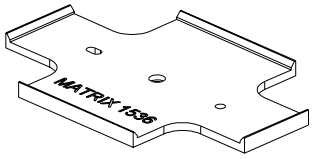


Figure 13: Matrix/Greiner 1536-well Microplates

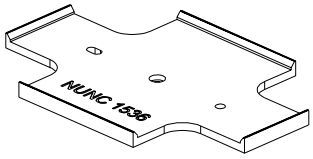


Figure 14: Nunc 1536-well Microplates

Refer to the following table for order information.

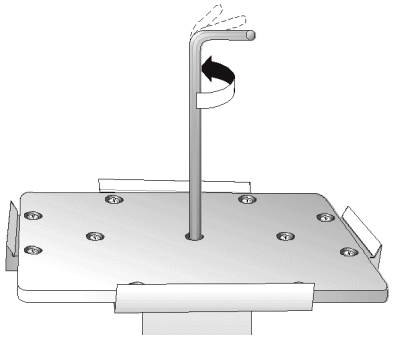
Catalog No.	Description
501-30016	Custom Plate Adapter (Nunc 1536-well microplates)
501-30017	Custom Plate Adapter (Matrix Snap Rack)
501-30018	Standard Plate Adapter (96 or 384-well microplates)
501-30024	Custom Plate Adapter (Genetix 384 polystyrene microplates)
501-30025	Custom Plate Adapter (Genetix 384 polypropylene microplates)
501-30026	Custom Plate Adapter (Matrix/Grenier 1536-well microplates)

For the latest pricing refer to the Matrix catalog.

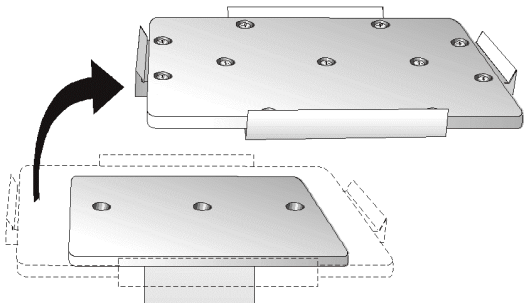
4.2.2 Changing Plate Adapter

Standard plate adapters can be changed easily to accommodate different plate formats.

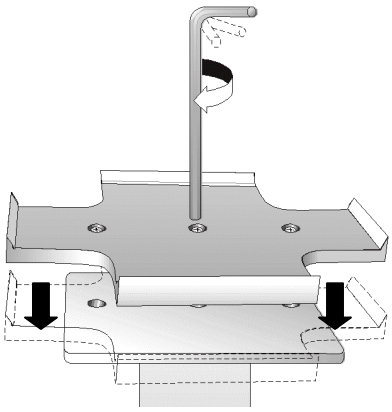
1. Loosen the center screw in the current plate adapter with an Allen wrench. Turn the Allen wrench **counter-clockwise** to loosen.



2. Remove the plate adapter.



3. Attach the new plate adapter and secure the center screw. Turn the Allen wrench **clockwise** to tighten.



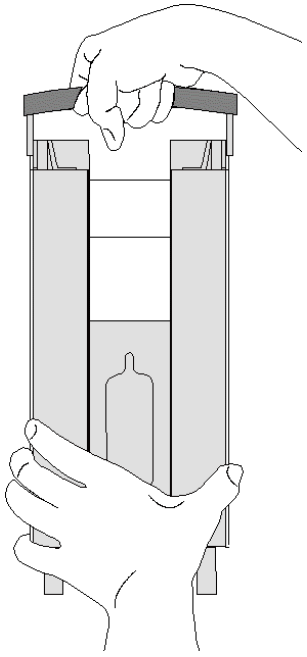
The new plate adapter is ready to receive the appropriate microplates.

4.2.3 Attaching Stackers

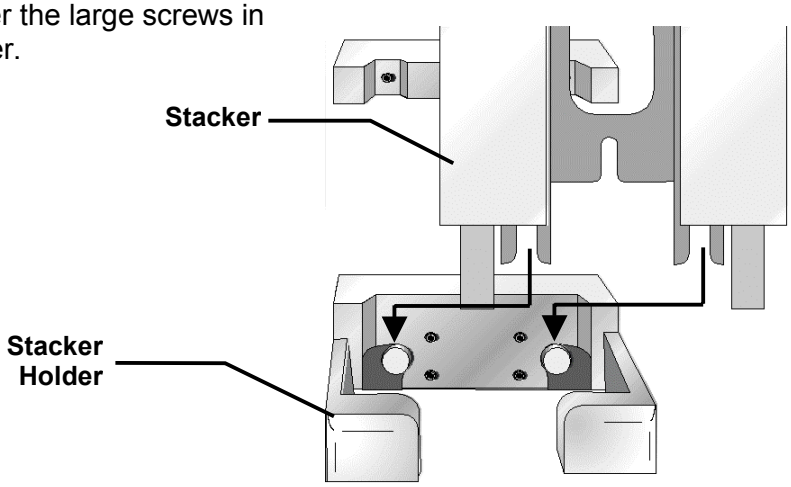
The stackers are universally designed to fit any one of the four stacker bases on the instrument. Any stacker can be used to *deliver* or *receive* microplates.

If your stackers are not already installed on the ***PlateMate Plus*** base, use the following procedure to install the stackers; otherwise, continue to the next section.

1. Hold the handle of the stacker with one hand and guide the bottom of the stacker into the stacker holder with your other hand.

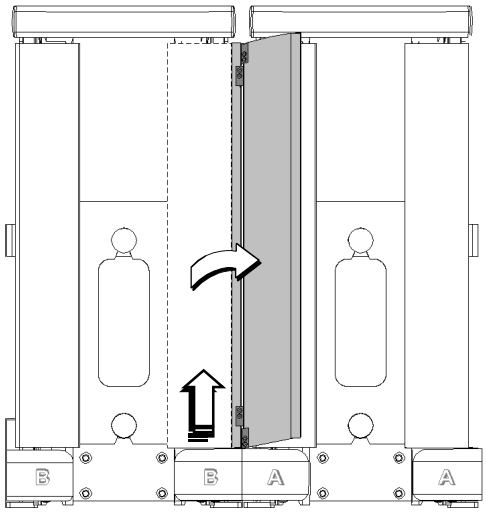


2. Slip the slots over the large screws in the stacker holder.



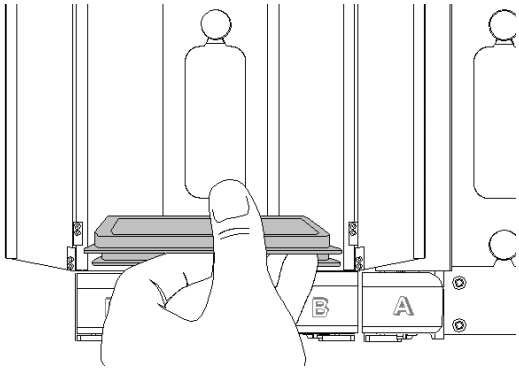
4.2.4 Add Microplates

1. Open each stacker door by lifting, then swinging it open.

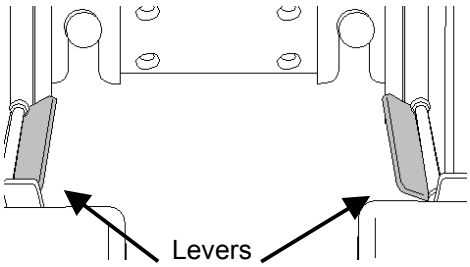


2. Add microplates to the appropriate stacker, and close the stacker doors.

Two solenoids in the stacker support frame hold the microplates in place.



When the stacker is not in the base unit, two levers at the bottom of the stack hold the microplates in place for easy storage and transport of plates in the stacker chimney.



4.2.5 Changing Pipettor Head and Tips

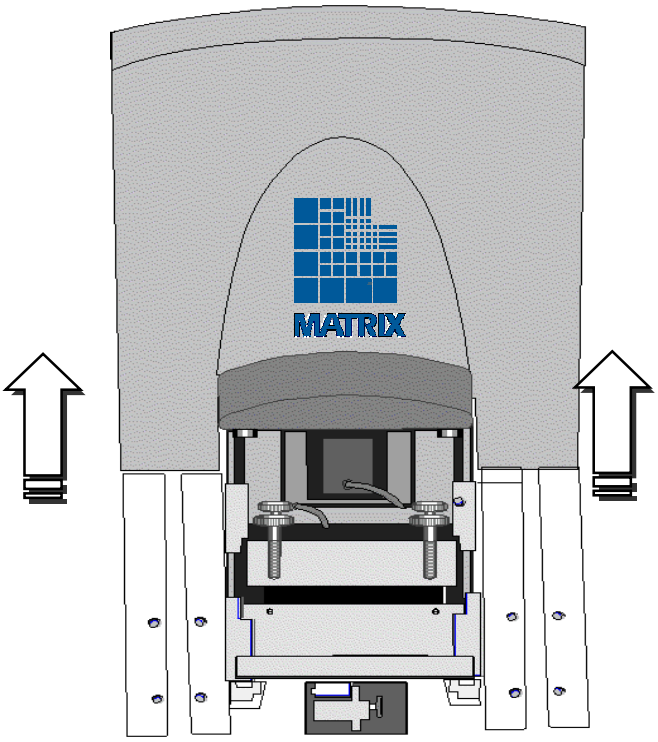
The ***PlateMate Plus*** can accommodate various pipettor heads, providing different volume ranges for either 96-channel or 384-channel formats.

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.

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

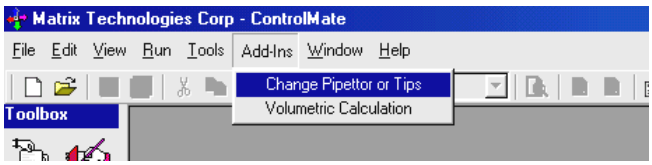
1. Start the ***PlateMate Plus*** by pressing the on switch in the lower right corner.

2. Lift the front cover of the ***PlateMate Plus*** to access the pipettor head.

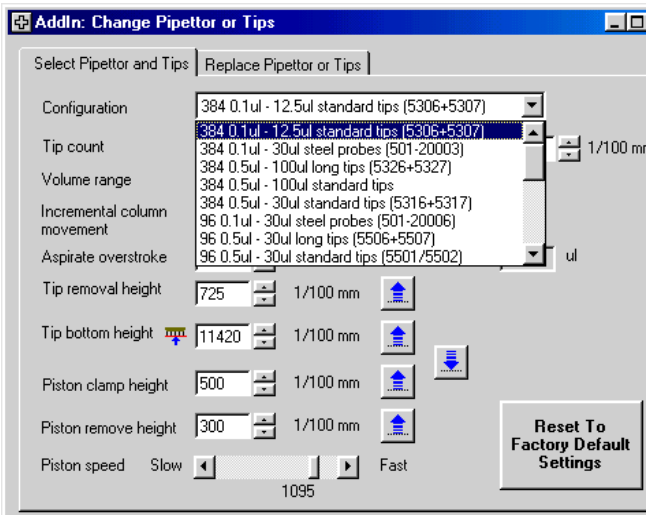


3. Turn on the PC and start the ***ControlMate*** software program.

4. In ***ControlMate***, select **Change Pipettor or Tips** from the Toolbar in the Add-Ins menu.



5. 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, and the wrong tip combination will cause the microplates and stages to crash into the tips and will result in improper volume accuracy.

6. Click **OK** to display the next screen.

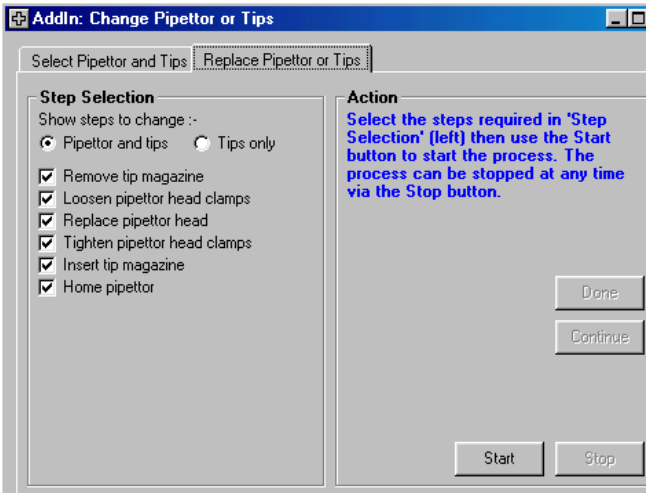
7. Select **Pipettor and tips** in the Step Selection box, if it is not already selected.

8. 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.

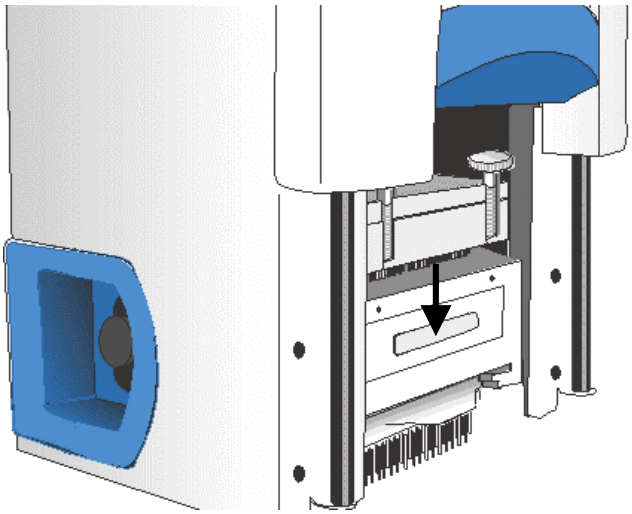
9. Click **Start**.

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

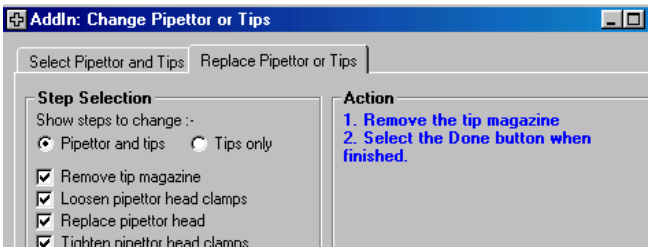


The piston motor moves down to loosen the tip magazine clamp.

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



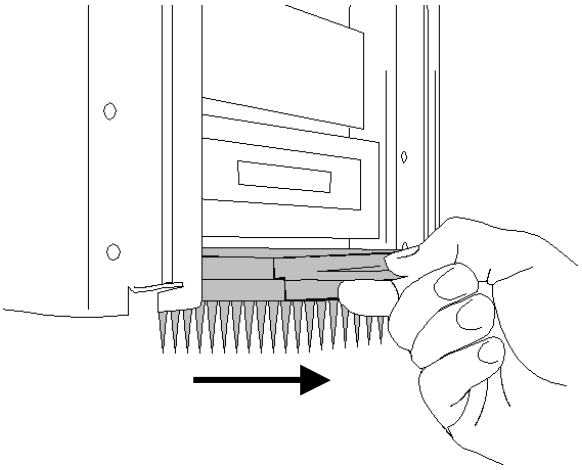
10. Read and follow the steps on the screen.



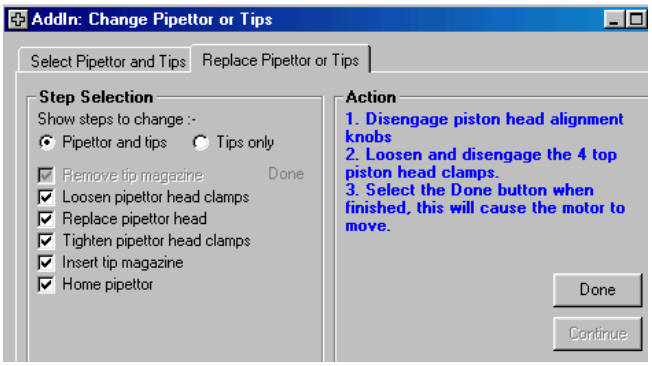
11. Remove the tip magazine from the instrument.

12. Click **Done.**

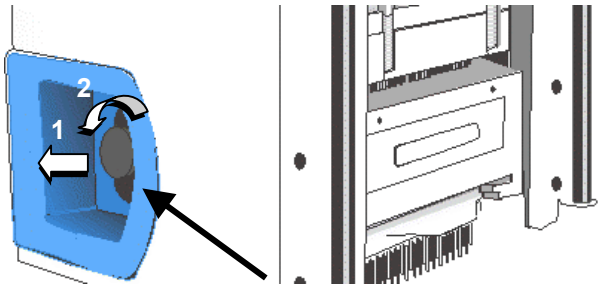
The instrument raises the pipettor head to prepare it for removal.



13. Read and follow the next set of steps described in the screen.



14. Pull out the alignment knobs on both sides of the pipettor housing and turn the knobs approximate ¼ turn in either direction to unlock the pipettor head.



Alignment Knob

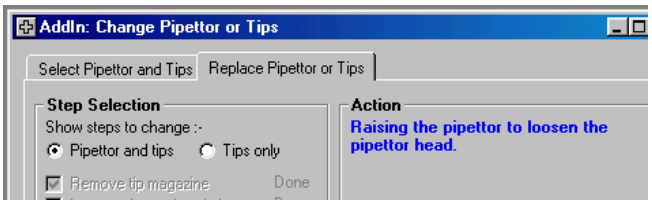
15. Loosen the four clamps that secure the pipettor head to the frame. Turn the clamps counter-clockwise to loosen.

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

16. Click **Done**.

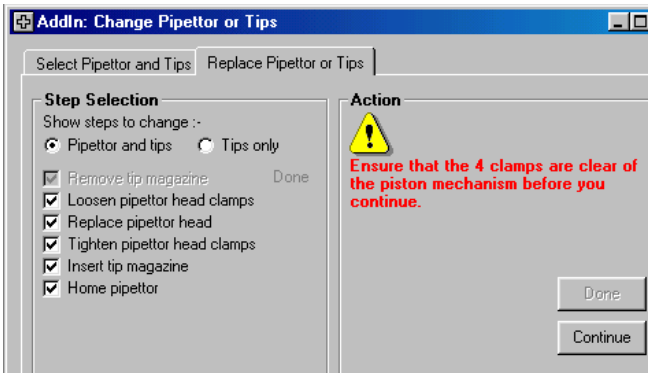
The next system action is displayed on the screen.

The system raises the upper portion of the piston back plate to loosen the pipettor head.

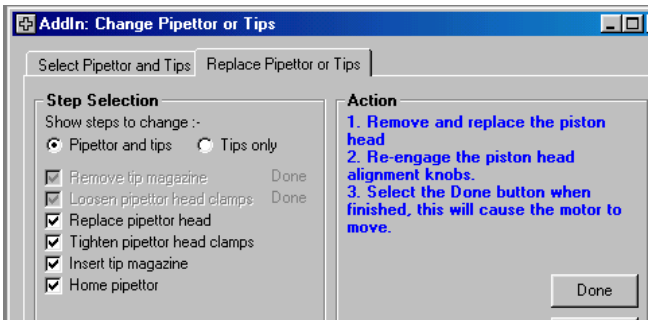


17. Take note of the warning in the screen, then click **Continue**.

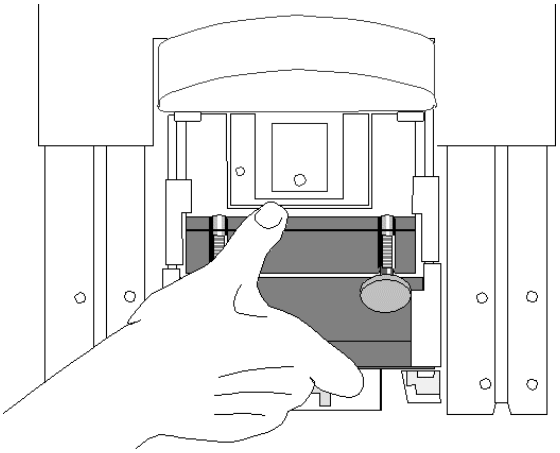
Note: This warning is a reminder to ensure that all four clamps are clear of the piston mechanism to prevent a possible jam in the following steps.



18. Read and follow the next set of steps described in the screen.



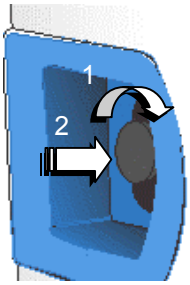
19. Grasp the front end of the pipettor head firmly and slowly pull it out of the frame.

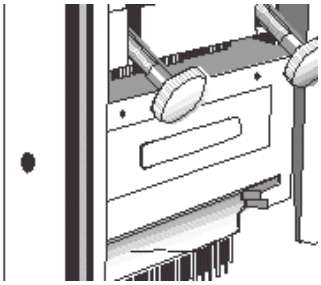


20. Insert the replacement pipettor head.

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.

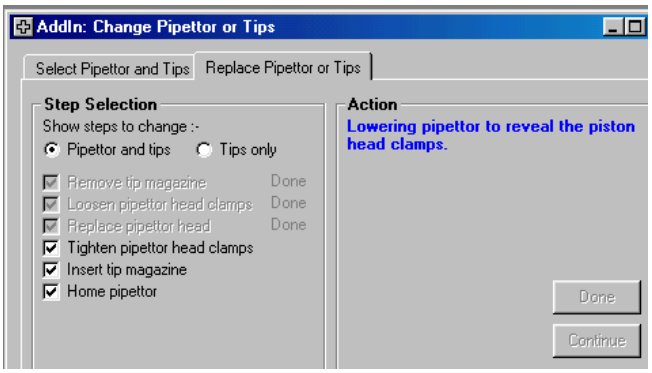
21. Turn both alignment knobs until they slip into the pipettor head and lock it in place.





22. Click **Done**.

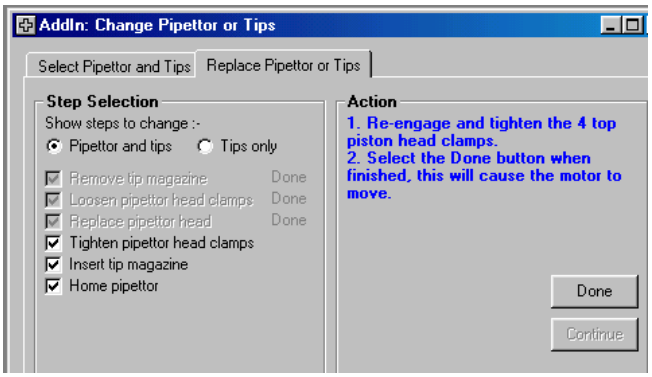
The system lowers the pipettor head to allow the pipettor head clamps to be tightened.



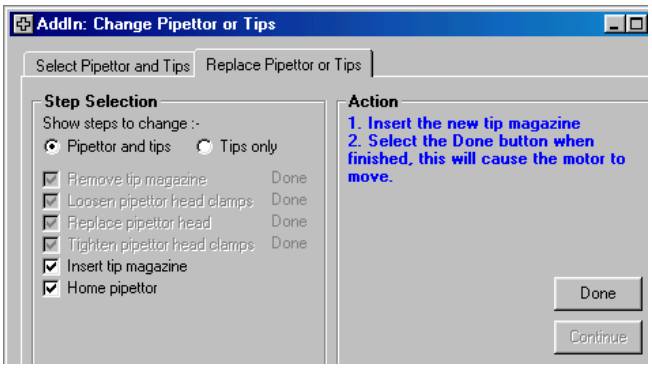
23. Hand-tighten all four knobs. Turn the clamps clockwise to tighten.

24. Click **Done**.

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



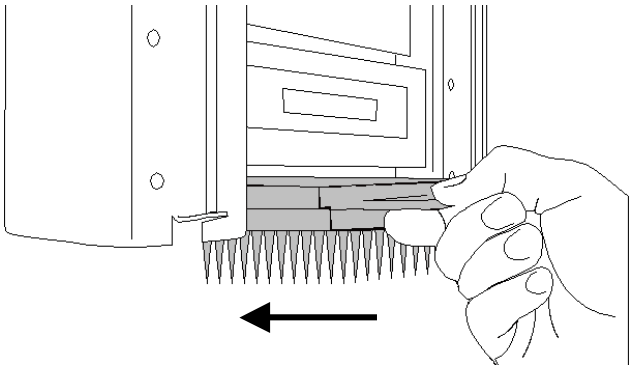
25. Read and follow the final set of steps.



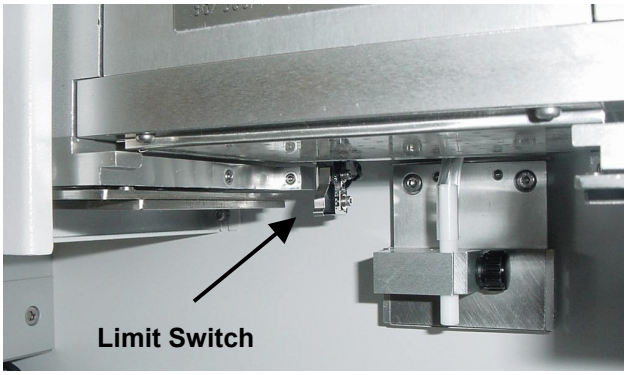
26. Insert the new tip magazine.

27. Click **Done**.

The system resets the pistons to the home position.



Note: If you click Done *before* inserting the tip magazine, you will receive a warning message. The limit switch must be activated by the tip magazine.



The ***PlateMate Plus*** is ready to run your pipetting program.

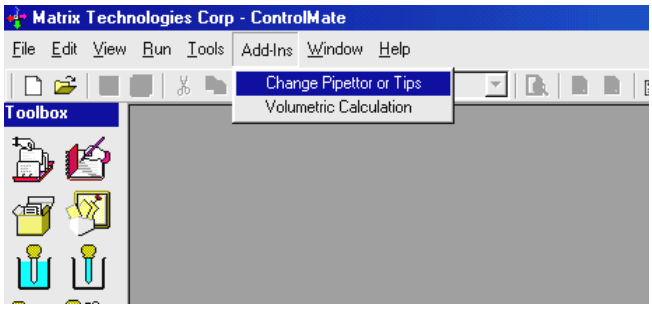
4.2.6 Changing Pipet Tips Only

Pipet tips can be replaced quickly and easily in the ***Plate*Mate Plus**. 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 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*.

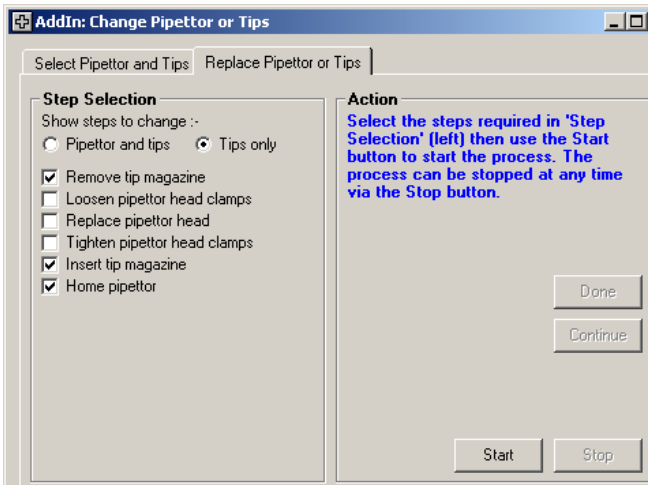
1. In the ***ControlMate*** software program, select **Change Pipettor or Tips** from the Toolbar from the Add-Ins menu.



2. Click **Replace Pipettor or Tips** tab.
3. Select **Tips only**. Only the steps associated with changing tips are checked in the Step Selection box.

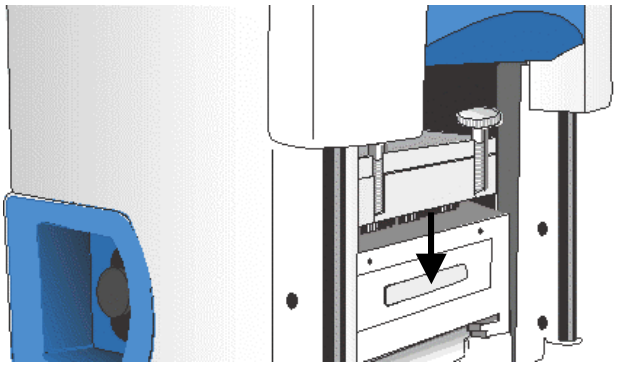
   The steps are shown in the Step Selection box in the order they should be performed.
4. Click **Start** to begin the instrument process.

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

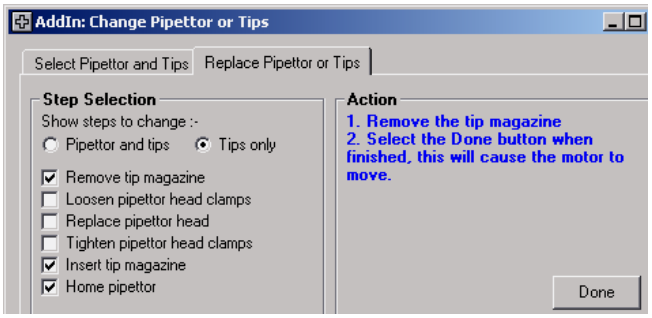


The piston motor loosens the tip magazine clamp.

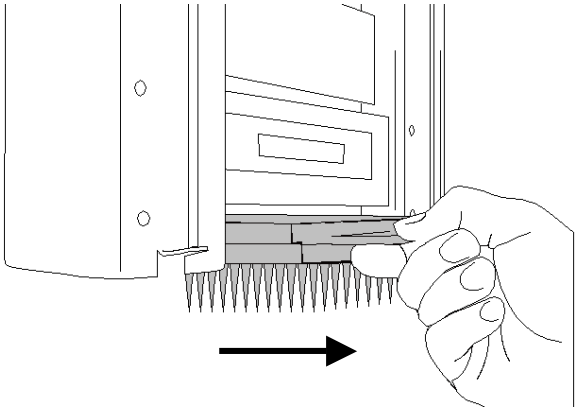
The software screen briefly describes each instrument action as it is performed.



5. Read and follow the steps on the screen.

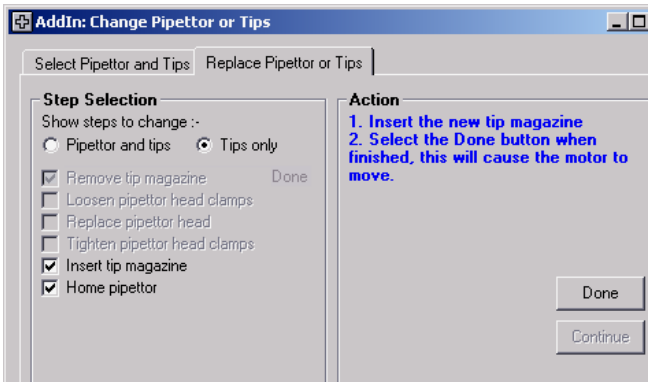


6. Remove the old tip magazine from the instrument.
7. Click **Done**.



8. Insert the new tip magazine.
9. Click **Done**.

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

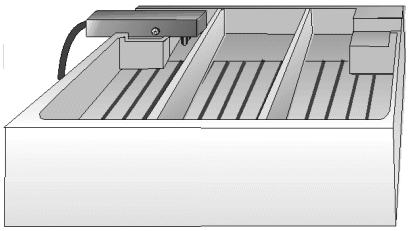


The ***PlateMate Plus*** is ready to run your pipetting program.

4.2.7 Using the Reagent Reservoir

Two types of reagent reservoirs are available for the ***PlateMate Plus***:

- **Automatic Fill Reservoir:**



Polypropylene or Teflon reservoir connects to the reagent line and automatically replenishes the volume. This version also comes with a level sensor to prevent overfilling.

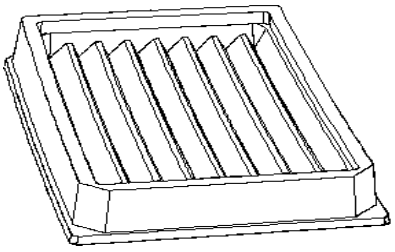
Automatic Fill Reservoirs are available in two volume capacities: 150mL for 96-well microplates; 50mL for 384-well microplates.

Refer to the following table for order information.

Catalog No.	Capacity	Material
501-30003	96-channel, 100µL	Polypropylene
501-30004	384-channel, 50µL	Polypropylene
501-30010	96-channel, 100µL	Teflon
501-30011	384-channel, 50µL	Teflon

For the latest pricing refer to the Matrix catalog.

- **V-bottom, Stackable Reservoirs (for 96-channel pipettors):**



Teflon or Delrin reservoirs are designed with the same base as a 96-well microplate, which enable them to be stacked and moved through the system. The small liquid capacity and stacking ability conserves reagent volume and allows for more than one buffer to be used.

Two different volume capacity reservoirs can accommodate maximum volumes of either 15ML or 30ML. Both sizes are available in two materials Teflon (for harsh solvents) or Delrin (for aqueous based reagents).

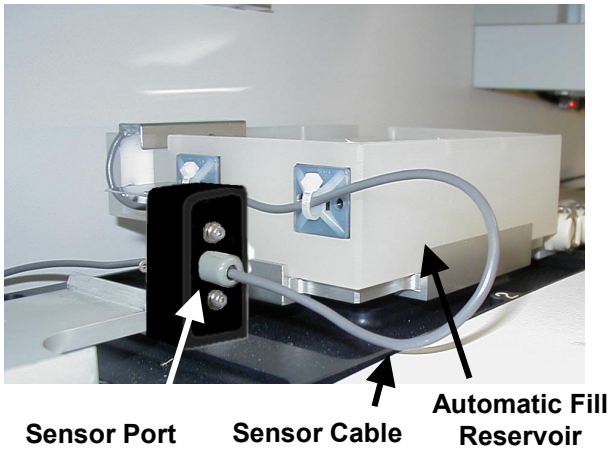
These reservoirs minimize reagent waste (1-2 mL)

Refer to the following table for order information.

Catalog No.	Capacity	Material
501-30027	30ML	Teflon
501-30028	30ML	Delrin
501-30029	15ML	Teflon
501-30030	15ML	Delrin

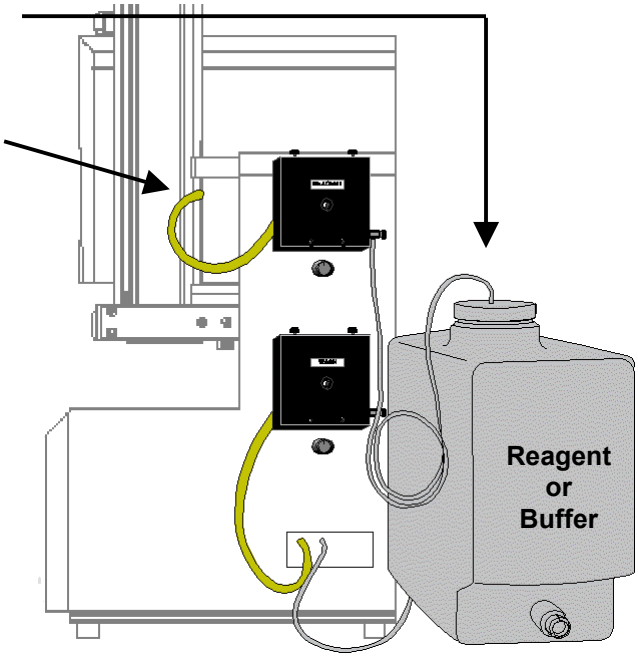
Attaching Automatic Fill Reservoir

1. Place the Automatic Fill Reservoir on platform stage 2. Orient the reservoir so that the metal sensor is in the left rear corner.
2. Insert the sensor cable into the sensor port.



3. Insert the tubing from the top peristaltic pump into the reagent or buffer container.

   The yellow tubing travels from the peristaltic pump to a fixed tube behind the pipettor head.



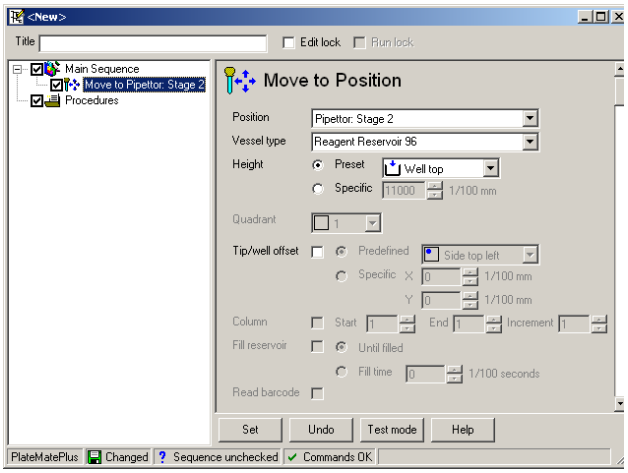
4. In ***ControlMate***, select **Move to Position** from the Toolbox.

   Toolbox>Move to Position:

5. In the *Position* menu, select **Pipettor Stage 2**.

6. In the *Vessel* Type, select Reagent Reservoir 96 or Reagent Reservoir 384.

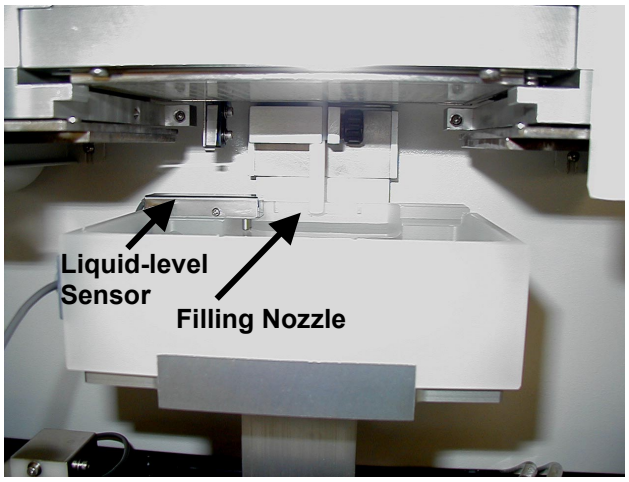
   - For 96- or 384-channel, checkmark **Fill Reservoir** and specify filling until the reservoir is filled or specific time.



Tip/well should be grayed out. Change example to 384

During a pipetting sequence, the system dispenses reagent through the fixed filling nozzle as the reservoir is raised to the pipettor tips (tips removed to show buffer tube). 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.



4.2.8 Using the Tip Wash Station

The Tip Wash Station allows you to wash both the interior and exterior walls of pipet tips or 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.

Note: The tip wash station is dedicated to platform stage 3. Always use tip wash on platform 3.

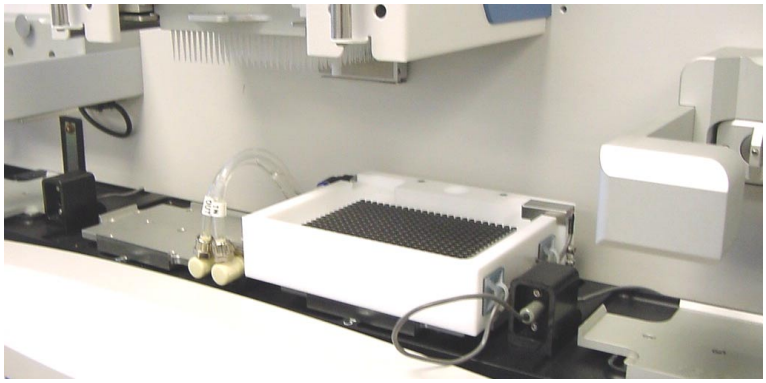


Figure 15: Tip Wash Station

A Tip Wash Station is available for 96-channel and 384-channel pipettor heads.

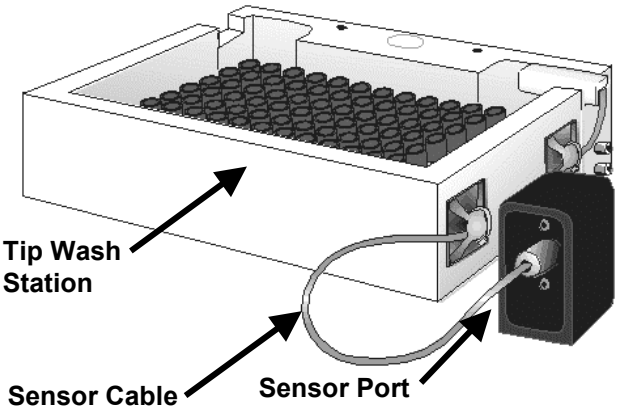
Refer to the following table for order information.

Catalog No.	Capacity	Material
501-30001	96-channel	Polypropylene/stainless steel
501-30002	384-channel	Polypropylene/stainless steel
501-30008	96-channel	PTFE/stainless steel
501-30009	384-channel	PTFE/stainless steel

For the latest pricing refer to the Matrix catalog.

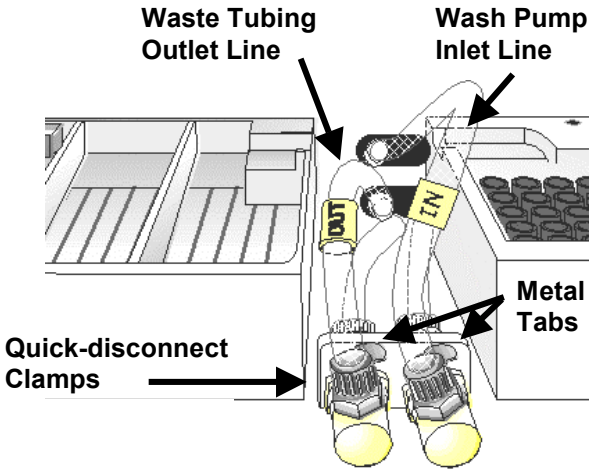
Attaching the Tip Wash Station

1. Place the Tip Wash Station on platform stage 3. Orient the station so that the metal sensor is in the right rear corner.
2. Insert the sensor cable into the sensor port.



3. Attach the wash tubing, labeled “IN” to the corresponding IN port on the microplate deck.
4. Attach the waste tubing, labeled “OUT”, to the corresponding OUT port on the microplate deck.

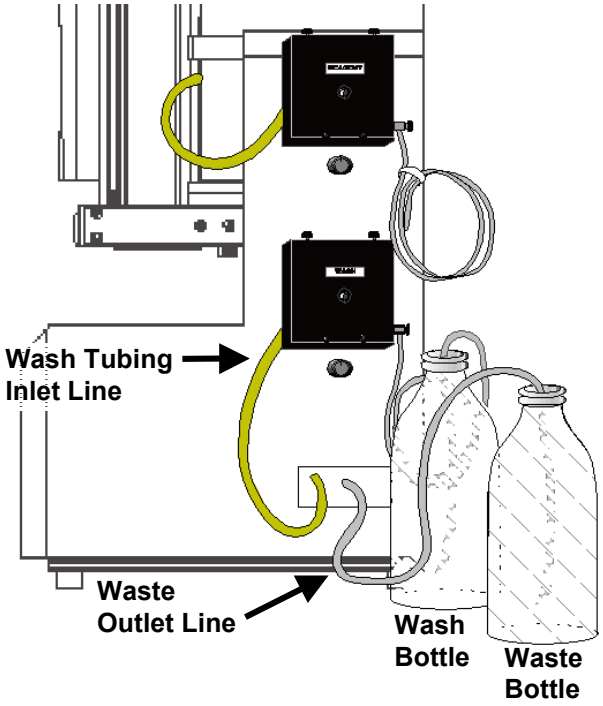
   The tubings are fitted with quick-disconnect clamps. To remove the tubings from the ports, press the metal tabs to release the clamps.



5. Insert the wash and waste tubings into the wash and waste bottles, respectively.

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

   The system removes the waste liquid from the tip wash station using a vacuum pump (internal, not shown). The waste tubing (labeled OUT) exits the system in the lower right corner on the right side of the instrument.

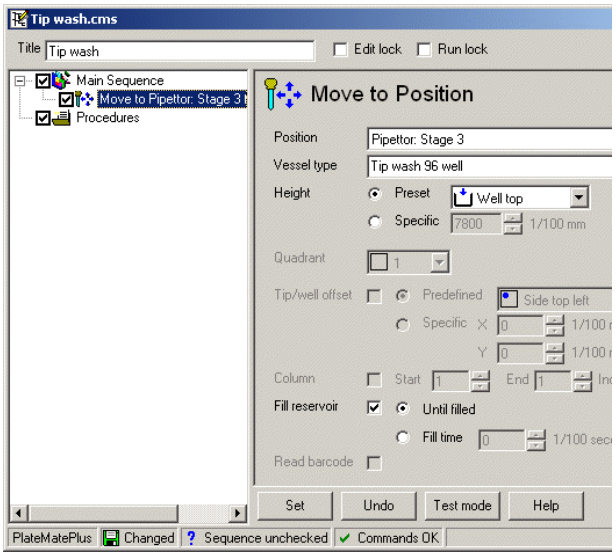


6. In ***ControlMate***, select **Move to Position** from the Toolbox.

   Toolbox>Move to Position:

   - In the *Position* menu, select **Pipettor Stage 3**.
   - In the *Vessel Type*, select **Tip wash 96 well** or **Tip wash 384 well**.

7. Checkmark **Fill reservoir** and specify filling until the reservoir is filled or specific time.

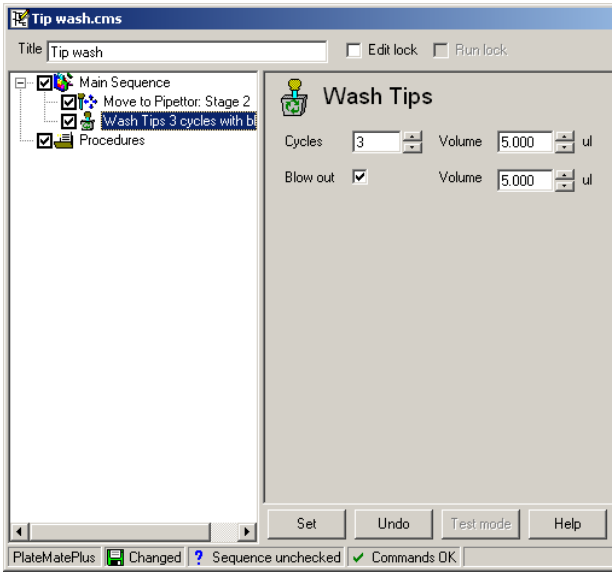


8. Select **Tip Wash** from the Toolbox.

   Toolbox>Tip Wash:

   - In *Cycles*, select the number of wash cycles
   - In *Volume*, select the wash volume.
   - Checkmark **Blowout** if you want to expel the remaining liquid.

9. Click **Set** to save the settings.



Tip Wash Sequence

The system moves the tip wash station up to the pipet tips until they are inserted into the wash channels. Refer to the diagram on the right.

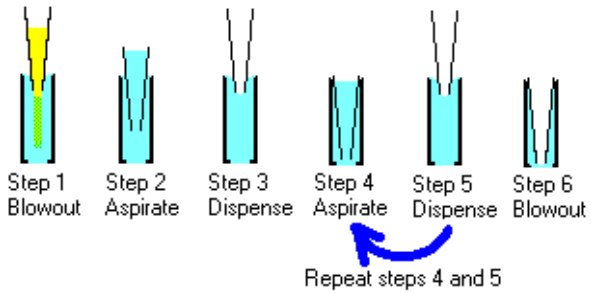
Step 1: The wash fluid enters through the wash channels to clean the outside of the pipet tips and spills into the surrounding basin. The pipet tips expel any liquid remaining in the tips.

Steps 2 and 3: At the same time, the system aspirates and dispenses wash fluid to clean the inside of the pipet tips.

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

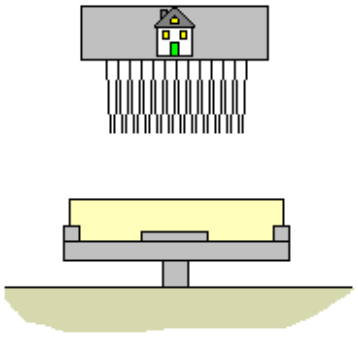
Step 6: The pipet tips expel any remaining liquid.

Step 7: The stage lowers while the vacuum pump drains the waste fluid from station.



Depths:
Step 1, 3 and 5 at dispense depth
Step 2 at aspirate depth
Step 4 and 6 at wash depth

Aspirate and Dispense depths can be set in Tools Options Plates
Wash depth set in Add-In Change Pipettor or Tips



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

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

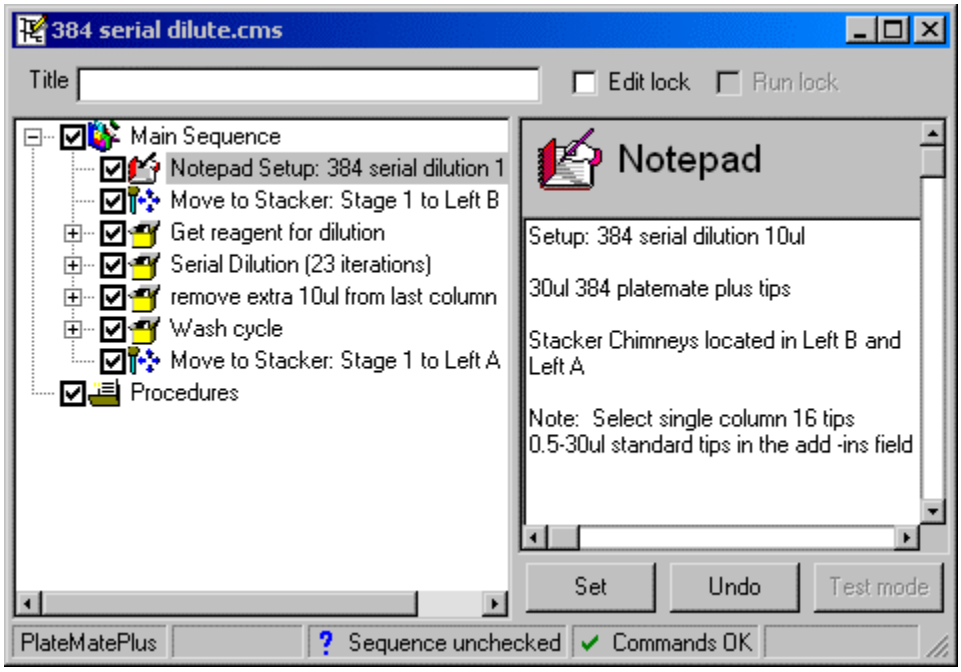
CAUTION! Although tip washing significantly reduces sample carryover by rinsing both the internal and external walls of the pipet tips, carryover is never completely eliminated. To ensure zero carryover Matrix recommends that pipet tips be replaced between sample transfers. This can be done manually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

4.3 Running Pipetting Program

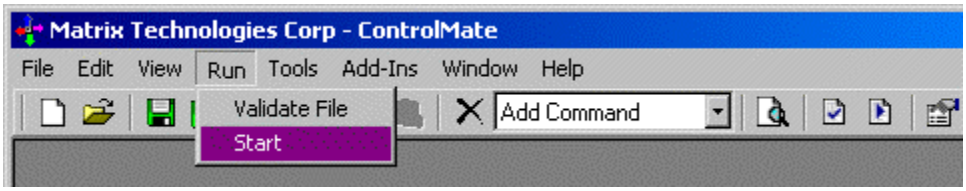
1. Add any other components needed for the pipetting program.
2. Start the ***PlateMate Plus*** instrument if it is not already started.
3. Prime buffer or reagent lines.

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

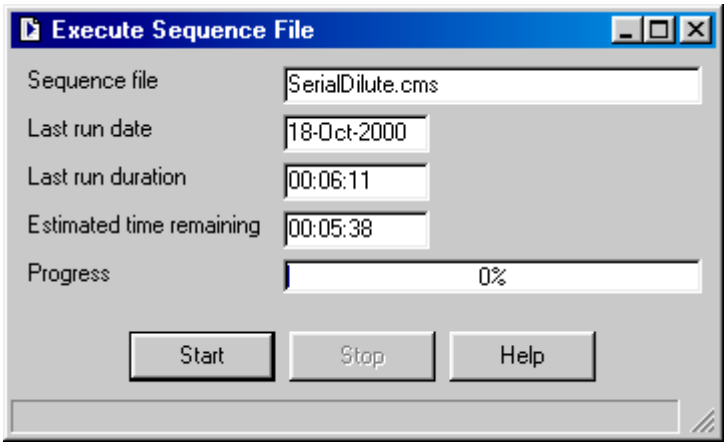
4. Start ***ControlMate*** and open the pipetting program to be run.
   a. Check the Notepad for setup instructions or last-minute notes.



   b. Select **Run**, then **Start** from the Tools Menu.



c. Review the program information in the Execute window and click **Start**.



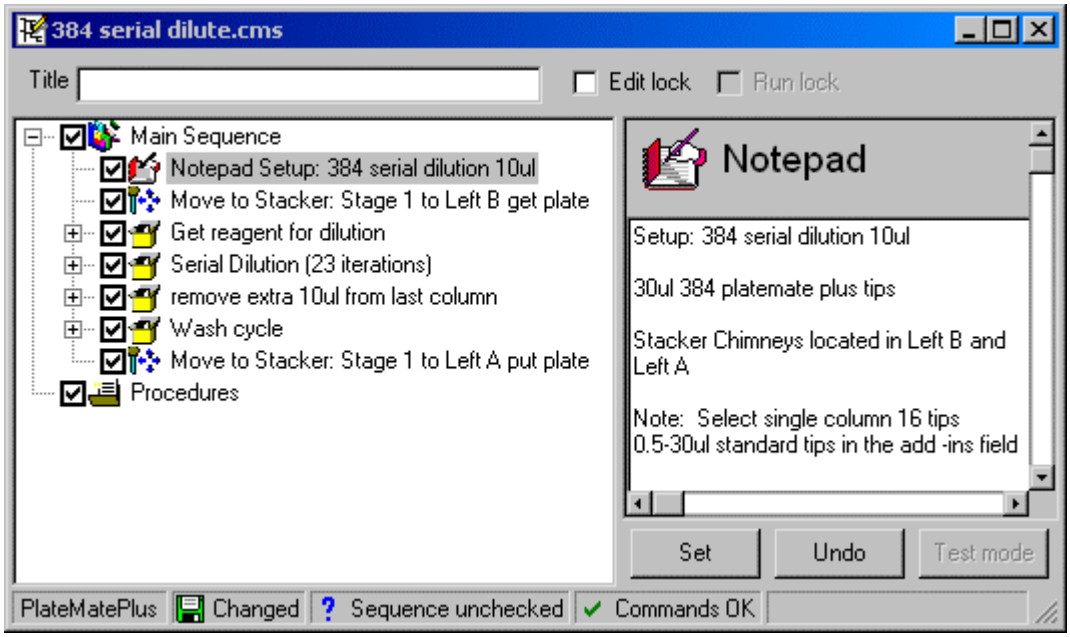
You can watch the percentage completion of the program in the Progress field.

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

4.3.1 Sample Pipetting Procedure

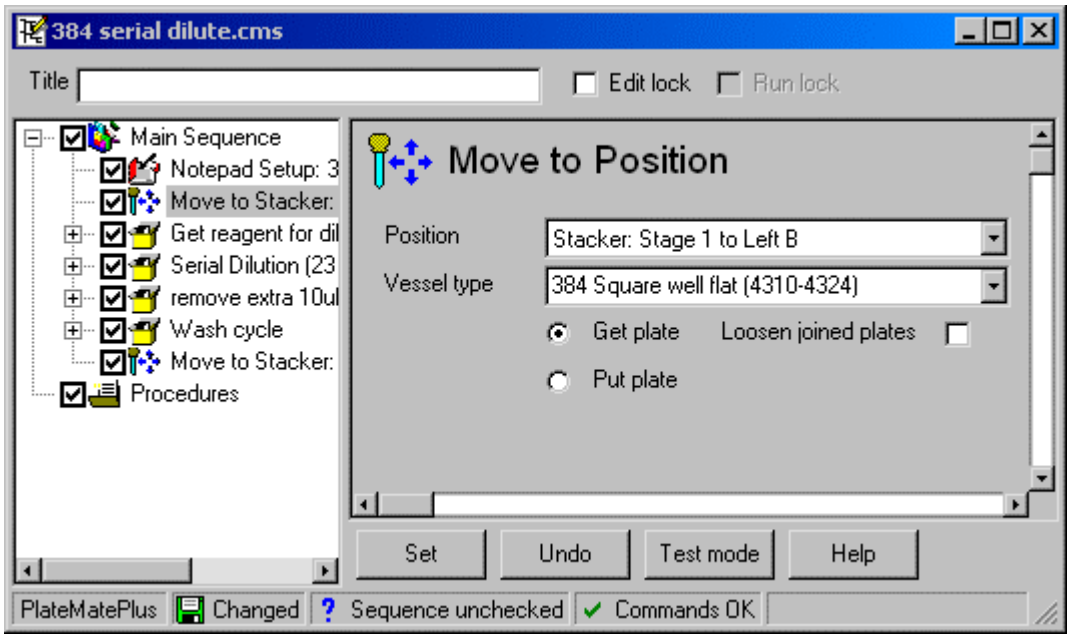
This section describes a sample pipetting procedure.

To perform a serial dilution, for example, use the following program:

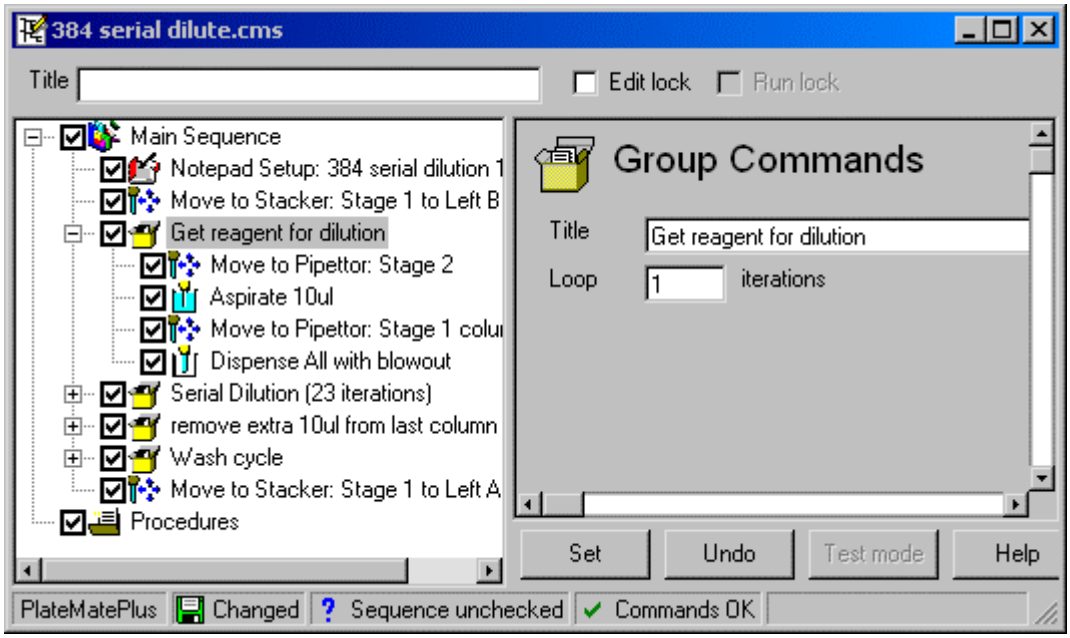


The Notepad provides detailed setup information to ensure that the correct tips and chimneys are used.

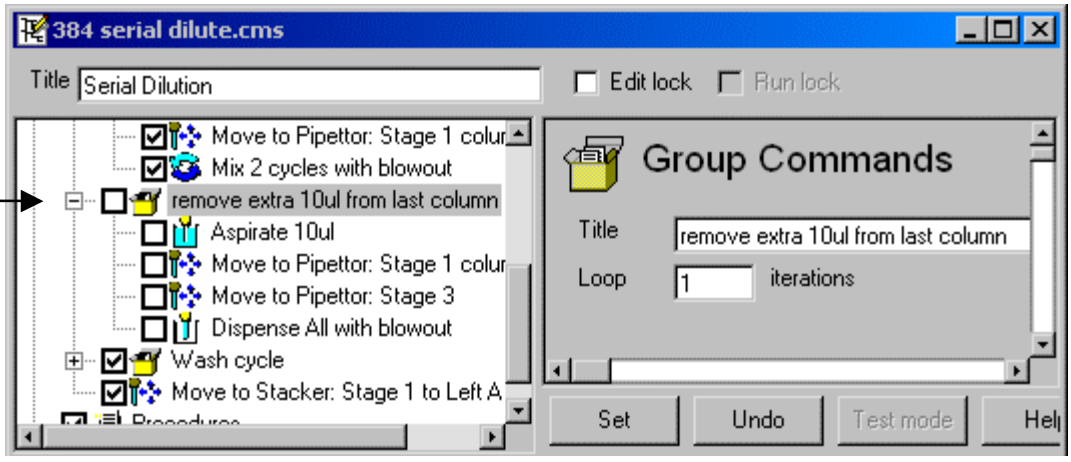
The first step, after the instrument is set up, is to move the first stage to the stacker containing the 384-well plates.



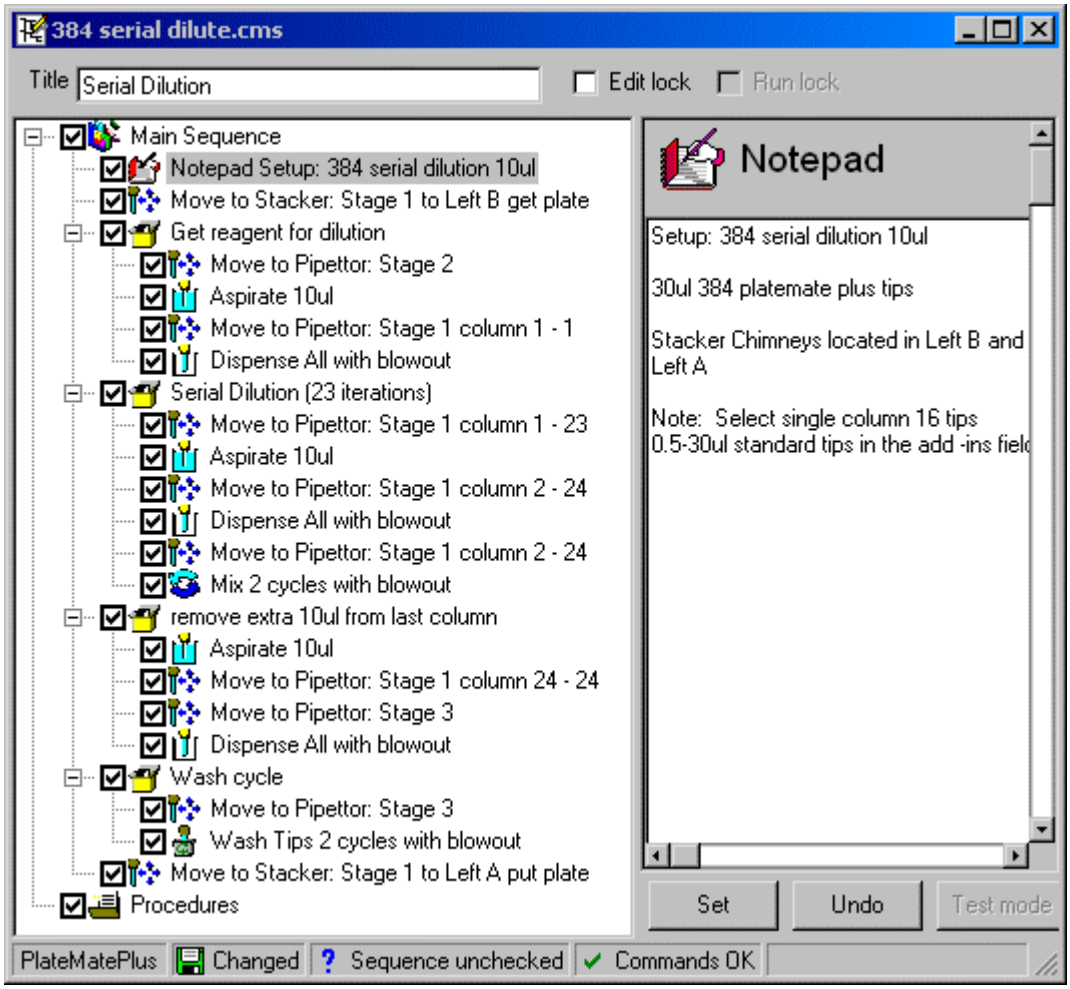
Subsequent steps are grouped according to their function, using the Group Commands icon. Group commands with descriptive titles make the program easy to follow.



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 serial dilution program.



4.4 Shutting Down

When you are ready to shut down the *Plate*Mate, 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. Flush the line with distilled water, if necessary.

- **Remove microplates.** Remove any coated microplates or v-bottom reservoirs, if necessary. You can remove the entire stacker of microplates and store it in the cold room or other protected area.

- **Shut down *Control*Mate.** 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 *Plate*Mate 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 ***PlateMate Plus***. It is used primarily for troubleshooting.

Figure 21: External Keypad

Call your Matrix representative for operating instructions.

5.2 PC Command-line (Host PC Communications)

PlateMate Plus 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 ***PlateMate Plus*** 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 ***PlateMate Plus*** dispense capabilities for dry plate dispensing of 0.5 to1.0 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:

PlateMate Plus Base Unit (Catalog 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 ***PlateMate Plus***
Multidrop 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 λ=485 nm, emission λ=535 nm, with 3 flashes per well.

The following table summarizes the precision results that were obtained:

Table 9: 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.

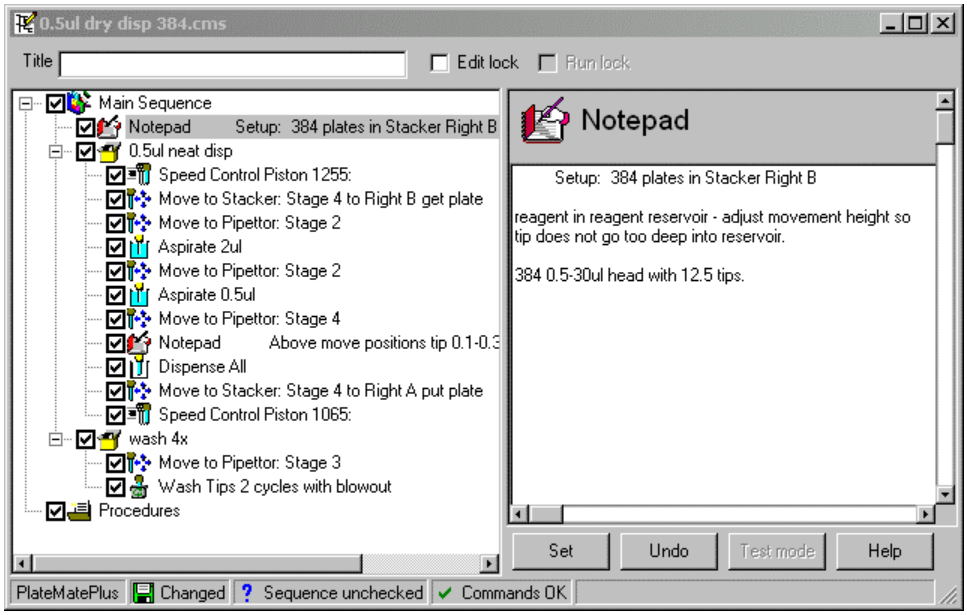


Figure 22: Dry Dispense using 0.5 mL

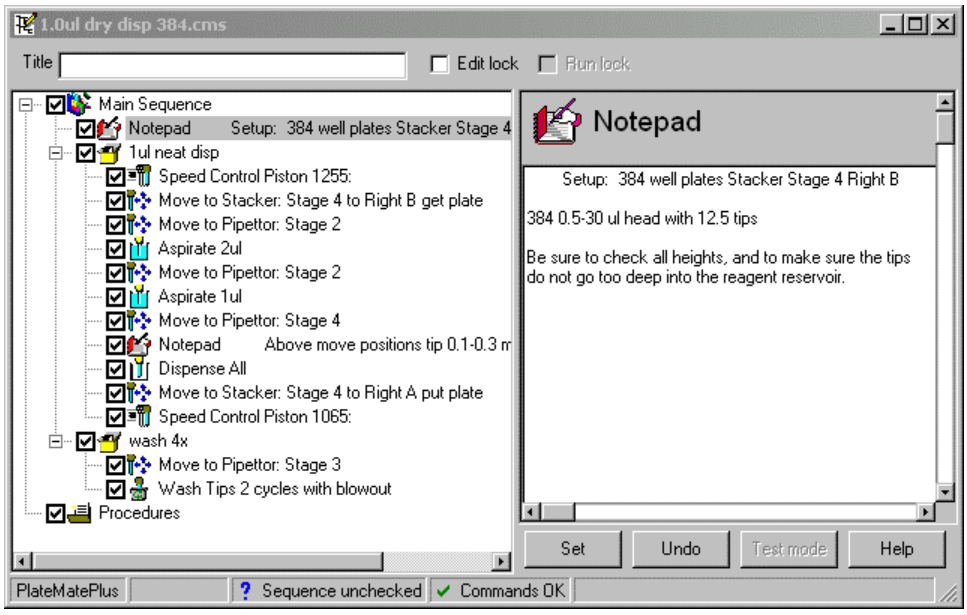


Figure 23: Dry Dispense using 1.0 mL

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).

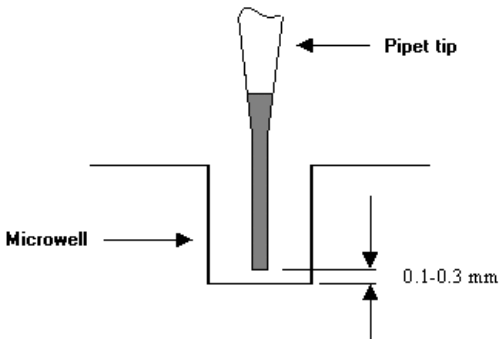


Figure 24: Position of the tip in the plate before dispense

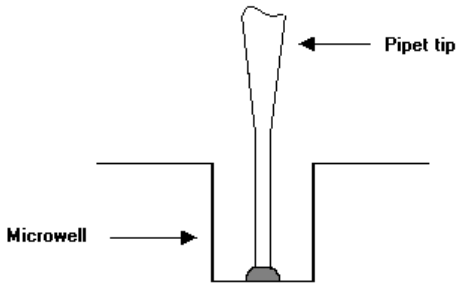


Figure 25: Position of the pipet tip during dispense of liquid and air blowout

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. (ie. 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)

PlateMate Plus 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 ***PlateMate Plus*** 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.

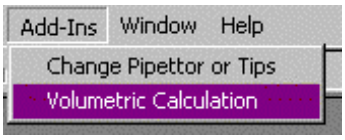
6.2.2 Calibration Procedure

Use the following procedure to calibrate ***PlateMate Plus*** 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 µL).

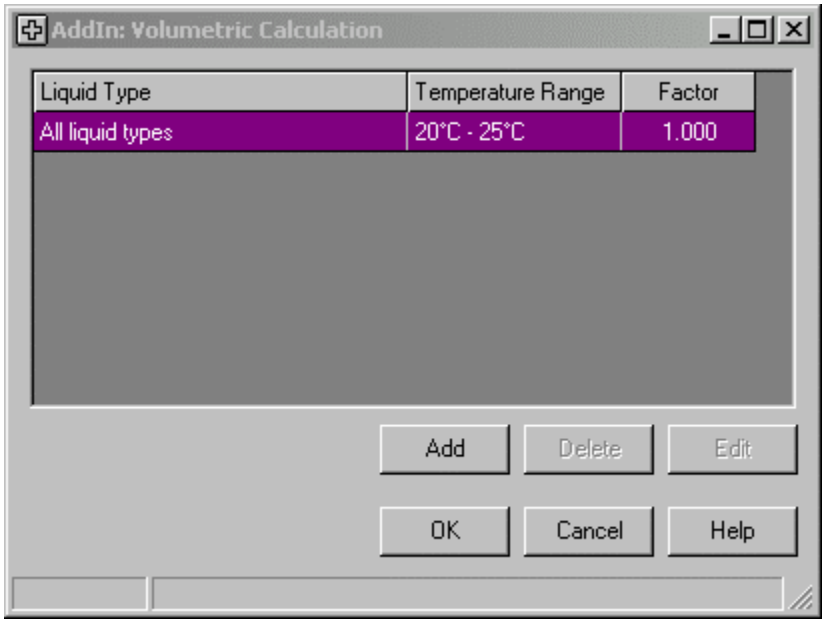
   Note: Since ***PlateMate Plus*** is calibrated to distilled water, it uses a motor factor setting of 1.000).

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.**

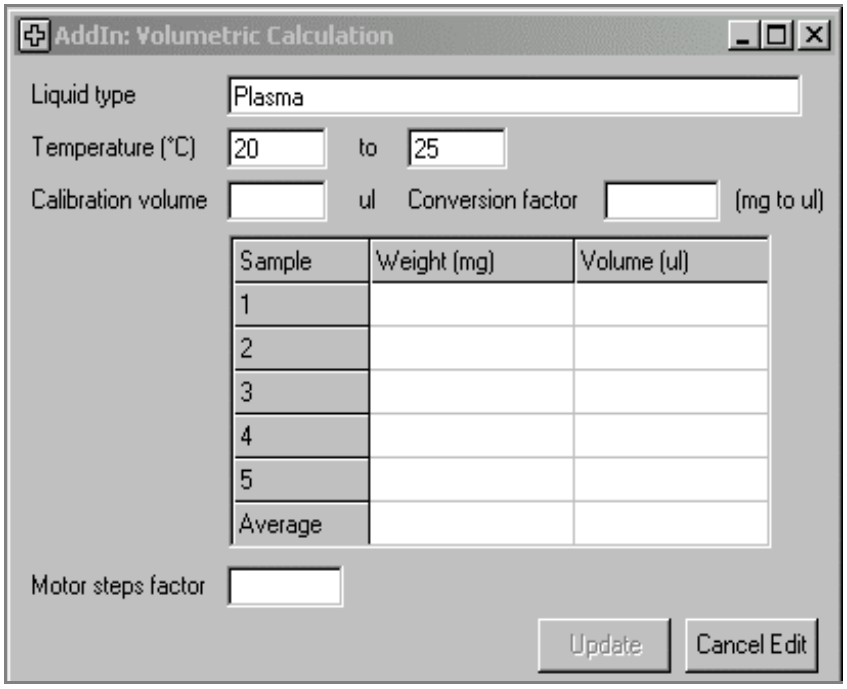
   The following window opens.



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

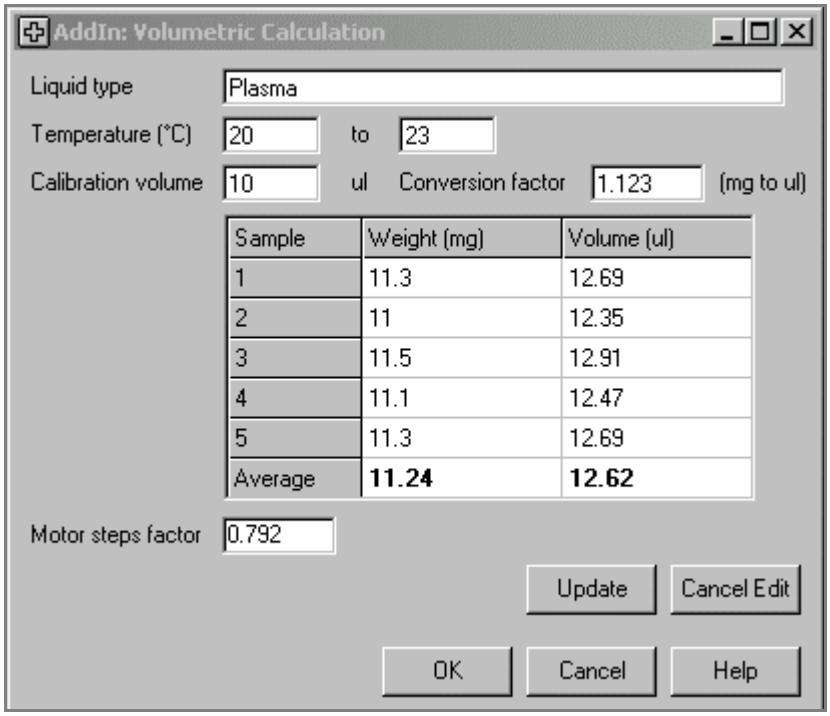
8. Click **Add** to create another liquid type.

9. Name the liquid type and calibration temperature.



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.

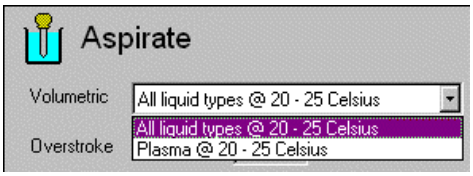
11. Enter the five gravimetric weights obtained in step 5.



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.



7 Maintenance and Service

7.1 Maintenance

7.1.1 Regular Inspections

Perform the following tasks before running the ***PlateMate Plus*** 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 pipet tip enters properly into the mouth of each container. If not, factory values need to be reset. Contact Matrix Technologies.
Leak test	Once weekly	After aspirating liquid, pause the instrument and confirm the liquid level in the tips. Allow the ***PlateMate Plus*** 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 Matrix Technologies, if a leak is observed.

7.1.2 Cleaning (as needed)

If a liquid is spilled during use, wipe it up immediately. If the machine is operating, stop the operation, and wipe the liquid up before continuing.

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.

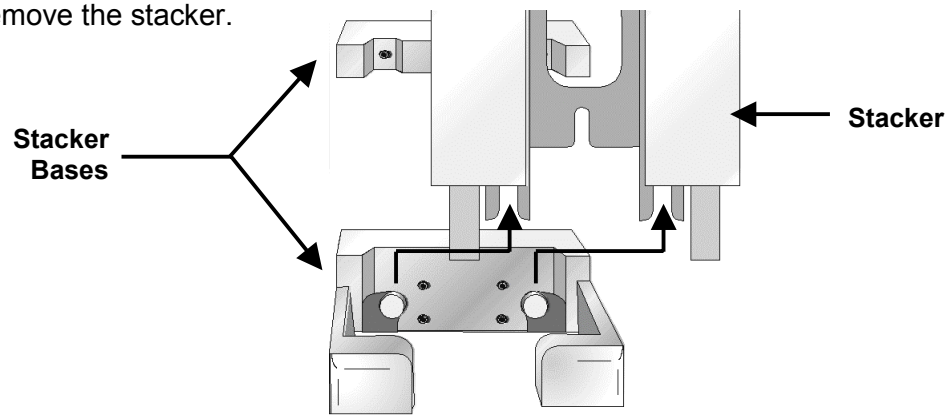
7.2 Service

7.2.1 Removing Stacker Bases

You can remove the stacker bases from the base unit if you plan to use the ***PlateMate Plus*** with robotics or other automation devices.

Use the following procedure to remove stacker bases:

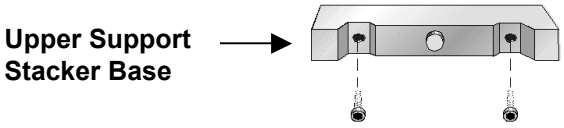
1. Remove the stacker.

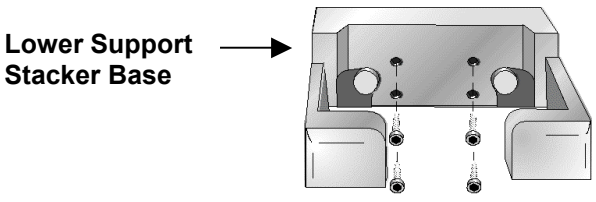


2. Remove all screws from both stacker bases.

The stacker bases are attached to the base unit with hex screws; use an Allen wrench to remove the screws.

- Two screws are located in the stacker base in upper support.
- Four screws are located in the stacker base in the lower support . The bottom stack also contains an electrical cable that controls the stacker solenoids.

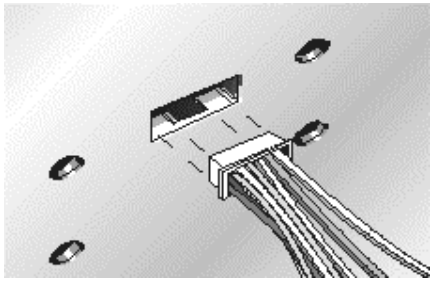




3. Remove the stacker bases from the base unit.

Note: When you remove the bottom stacker base, carefully pull the holder from the base unit to reveal the cable connected between the stacker base and the base unit.

4. Gently pull the cable from the base unit to remove the bottom stacker holder.



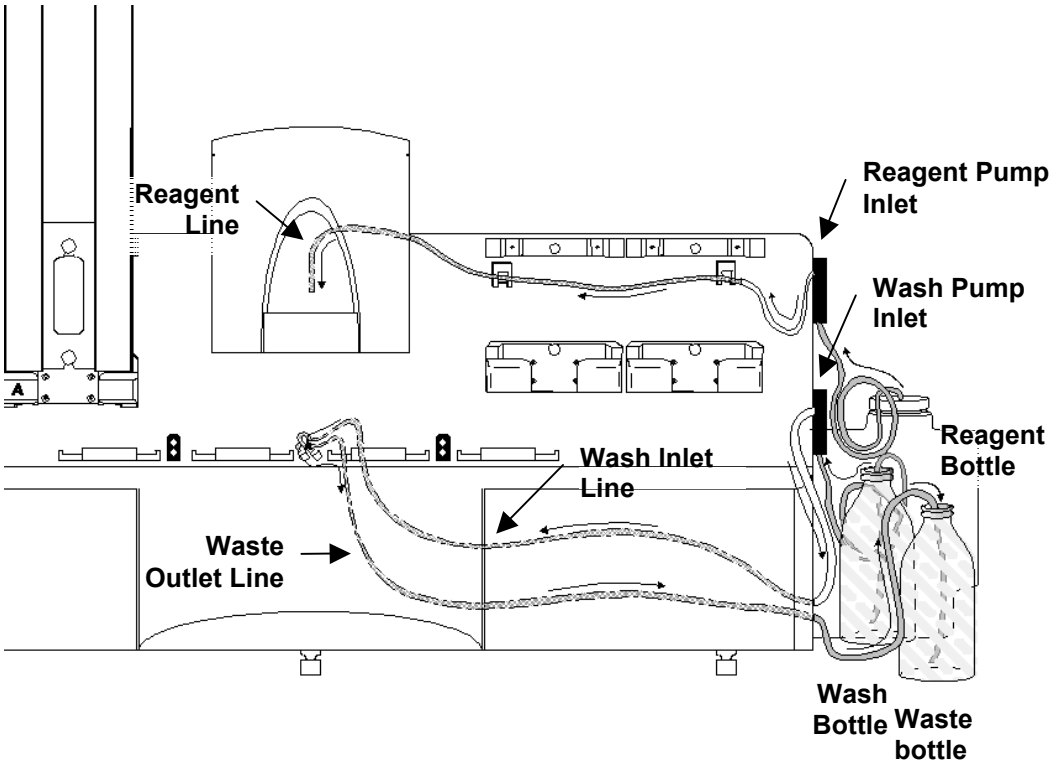
The ***PlateMate Plus*** is ready for automation. Using ***ControlMate***, you can raise Stage 4 to work with other devices.

Figure 26: Stage 4 in Position for Automation

7.2.2 Replacing Tubing

The ***PlateMate Plus*** is designed with quick-disconnect fittings and removable pump covers to easily replace the Wash Inlet and Waste Outlet Lines.

The following drawing shows the path of the wash and waste lines.



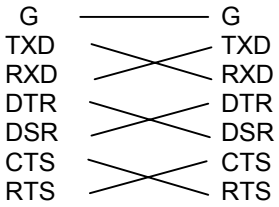
Both Wash and Waste lines use clear Tygon 2075 tubing inside the instrument and Pharmed tubing in the peristaltic pumps. Refer to the Matrix catalog for replacement tubing.

A Host PC Communication

A.1 Hardware Specifications

(1) 9600 bps. STOP 1, PARITY-EVEN, X NONE, BITS-7
ALL ASCII

(2)



(3) Essential Message Format

SXT ######## EXT
SXT (02H): Start of message
EXT (03H): End of message
Any message not included in SXT and EXT should be ignored as noise.

(4) Transmission Protocol

a. Transmit → Correct receive
← ACK

b. Transmit → Incorrect receive
No response

2 seconds delay

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 ***PlateMate Plus***.

(5) Common Message

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

A.2 Basic Message Specification

(1) STX + Discrimination + DATA + ETX

A.3 Control Commands

Host ——► *PlateMate Plus*

1) O : COM PORT Open command.
2) R : RESET Command Each axis returns to home position.
3) X0 : ZB moves to ST-B. Stage 2 to left stacker chimney A
4) X1 : ZA moves to ST-A. Stage 1 to left stacker chimney B
5) X2 : ZA moves to ST-B. Stage 1 to left stacker chimney A
6) X3 : ZD moves to ST-C. Stage 4 to right stacker chimney B
7) X4 : ZD moves to ST-D. Stage 4 to right stacker chimney A

8) X5 : X axis. Stage ZA moves to below the pipetting head.
X5±OOOO : Moves from the center position of pipetting head to + or - direction.
STX X 5 + 0090 ETX
STX X 5 - 0090 ETX

9) X6 : X axis. Stage ZB moves to below the pipetting head.
X6±OOOO : Moves from the center position of pipetting head to + or - direction.

10) X7 : X axis. Stage ZC moves to below the pipetting head.
X7±OOOO : Moves from the center position of pipetting head to + or - direction.

11) X8 : X axis. Stage ZD moves to below the pipetting head.
X8±OOOO : Moves from the center position of pipetting head to + or - direction.

12) X9 : ZC moves to ST-C.

13) XSOOOO : Set up X axis speed
XS1022 ~ XS1255 1022 5400 PPS
1255 470 PPS

14) YOOOO : Moves Y axis to OOOO address
Y0000 ~ 0001 = 0.05mm

15) YSOOOO : Set up Y axis speed
YS1032 ~ YS1255 1032 3700 PPS
1255 470 PPS

16) ZAOOOO : Moves ZA axis to OOOO address
ZA0000
17) ZBOOOO : Moves ZB axis to OOOO address
18) ZCOOOO : Moves ZC axis to OOOO address
19) ZDOOOO : Moves ZD axis to OOOO address

20) ZSOOOO : Set up Z axis speed
ZS1010 ~ ZS1255

21) S±OOOO : Moves S axis to ±OOOO address S = Syringe Motor
Determine the READY position as ±0000 and regard the piston position above it as + area and below it as - area.

The syringe motor cannot be moved from + area to - area or from - area directly to + area. In order to perform the above movement, reset S axis to ±0000 address once, then move it to the required address by the next command.

Message to move from + area to ±0000 address is
EX S+0000 SX.

Message to move from - area to ±0000 address us
EX S-0000 SX.

22) SSOOOO : Set up S axis speed

SS1032 ~ SS1255	MAX SPEED	1032
	384 HEAD MAX SPEED	1045
SS0020 ~ SS0255	MIN SPEED	0255

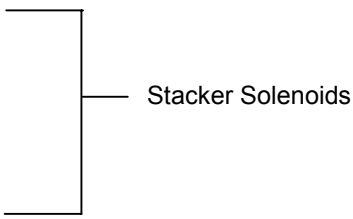
23) M10 : Reagent Motor OFF
M11 : Reagent Motor ON
If the reservoir sensor is ON, M11 command cannot make the Reagent Motor ON.

24) M20 : Washer Motor and Waste Motor OFF (Tip wash station pump)
M21 : Washer Motor and Waste Motor ON (Tip wash station pump)
If the washer sensor is ON, M21 command makes only Waste Motor ON

Washer Motor can be ON after the washer sensor is OFF.

25) M30 : Waste Motor OFF
M31 : Waste Motor ON

26) CA0 : Stacker A Coil OFF
27) CA1 : Stacker A Coil ON
28) CB0 : Stacker B Coil OFF
29) CB1 : Stacker B Coil ON
30) CC0 : Stacker C Coil OFF
31) CC1 : Stacker C Coil ON
32) CD0 : Stacker D Coil OFF
33) CD1 : Stacker D Coil ON



34) P : Each axis temporary stop command
35) A : Restart after the temporary stop
Restart after each error stop

36) QX : Find X axis address
37) QY : Find Y axis address
38) QZA ~ QZD : Find ZA ~ ZD axis address
39) QS : Find S axis address

40) QT : Find if a tip holder is on or not
41) QA : Find if a stacker A sensor is ON
42) QB : Find if a stacker B sensor is ON
43) QC : Find if a stacker C sensor is ON
44) QD : Find if a stacker D sensor is ON
45) QF : Find if a reservoir sensor is ON
46) QW : Find if a washer sensor is ON

47) WOOO : Delay 001 ~ 250 (1=10mS. MAX 2.5S)
48) B0 : Do not use bar code reader.
49) B1 : Use bar code reader.
50) BR : Bar code read command.

Remarks

1) Address of each axis at the READY position (Home Position)
   X : 0000
   Y : 0090
   ZA ~ ZD : 0000
   S :±0000

2) Message including SX and EX can be transmitted up to 255 bytes. The system starts operation immediately after receipt of the message.

3) Any error of all message cannot be judged before execution, however, if it is found during execution system stops operation shortly before the error and transmits “E99” message.

   SX X5ZC0400S1000ZC0000 EX
   Stop here and transmit “E99” (Impossible to continue)
   Correct command is “S+1000”

4) When X1~X4 message is executed, Y axis moves automatically. In this case, Y axis should be reset to home position (Y0090) after de-stacking and stacking the plate.
   ZA0000Y0090
   After Stage A moves to 0000 address,
   Y axis moves to home position.

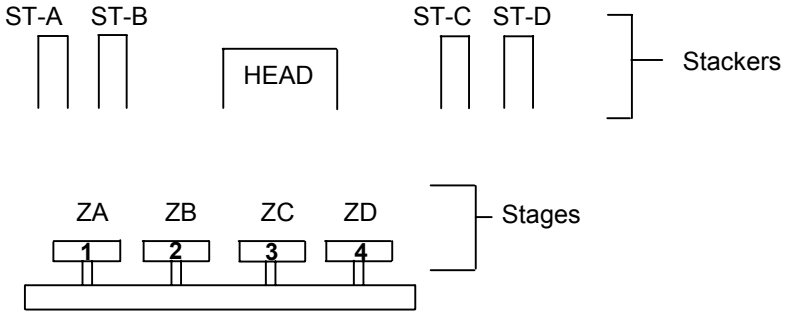
5) If any of ZA0000, ZB0000, ZC0000, or ZD0000 is executed, ZA~ZD axis moves to home position after confirming its own position. If there is any discrepancy in the position, the system stops by transmitting “E03~E06” message and waits for “A” or “R” command. The system resumes operation when the “A” command is transmitted after the discrepancy is removed.

6) If the motor direction must be reversed, insert a waiting time of at least 150mS.

   “S+5000W015S+0000”

7) Do not turn the plunger coil of the stacker for more than 10 seconds continuously. The inside resistor will be overheated.

8) Position of the stacker and stage in the command.



9) Set up of S (Syringe) axis should be determined by actual measurement of the speed.

Calculated speed changes at the starting time and stopping time, therefore, it is not correct.

10) Increments of each axis:

X : 0.05mm / 1 address
Y : 0.05mm / 1 address
Z : 0.06mm / 1 address
S :

96ch/300µl Head: 3.5mm diameter Piston
1.75 x 1.75 x 3.14 = 3.6(µl) / 1(mm) = 250 address
300(µl) = S+0000 ⟶ S+7799

384ch/30µl Head: 1.5mm diameter Piston
0.75 x 0.75 x 3.14 = 1.766(µl) / 1(mm) = 250 address
30(µl) = S+0000 ⟶ S+4246

384ch/100µl Head: 2.0mm diameter Piston
1 x 1 x 3.14(µl) / 1 (mm) = 250 address
100(µl) = S + 0000 ⟶ S+7962

SX$: "S+5000W050SS1100S+0000SS0040S-1500W050S-0000SS1032";
"XS1100X6ZB0900M11W200M10ZB0000";
"X7ZC0900M21W200M20ZC0000";EX$

PlateMate Plus ⟶ Host Message

1) R : READY (Each axis at Home Position)
STX R ETX

2) OK : Completion of correct execution of received command
STX OK ETX
If "R" is executed, the system transmits "R" instead of "OK."

3) XOOOO : X axis address
4) YOOOO : Y axis address
5) ZA~ZDOOO : ZA~ZD axis address
6) SOOOO : S axis address

7) P : Complete stop of each axis after receipt of "P" command

8) TO : Tip holder is not on
9) T1 : Tip holder is on
10) A0 : Stacker A Sensor OFF
11) A1 : Stacker A Sensor ON
12) B0 : Stacker B Sensor OFF
13) B1 : Stacker B Senor ON
14) C0 : Stacker C Sensor OFF
15) C1 : Stacker C Sensor ON
16) D0 : Stacker D Sensor OFF
17) D1 : Stacker D Sensor ON
18) F0 : Reservoir sensor OFF
19) F1 : Reservoir sensor ON
20) W0 : Washer sensor OFF
21) W1 : Washer sensor ON

22) BD : Transmit bar code data

23) Error message
E01 : Error at X axis
E02 : Error at Y axis
E03 : Error at ZA axis
E04 : Error at ZB axis
E05 : Error at ZC axis
E06 : Error at ZD axis
E07 : Error at S axis

E10 : Failure communicating with bar code reader.
E11 : Failure reading bar code reader

E99 : COM ERROR (There is a mistake in the command.)

Barcode Communication

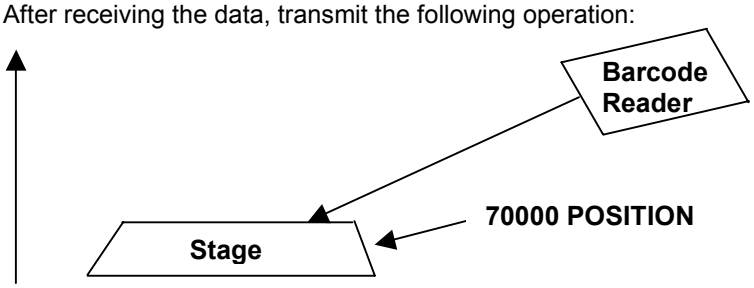
1) Connect the bar code reader to COM2.

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 an 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. PlateMatePlus.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 and unless a command is changed (added, deleted, moved or a field amended) it does not need further validation, this reduces the 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 ***PlateMate Plus*** 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 Tools – Option – Limits tab	1

External parameters may change the values within the rules set, for example changing a ***PlateMate Plus*** 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 a program values 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 not a 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 ***PlateMate Plus*** 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 and if 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 ***PlateMate Plus*** 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 a 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 ***PlateMate Plus*** **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 DISPENSVOL 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 ***PlateMate Plus*** 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 and unless a command is changed (added, deleted, moved or a field amended) it does not need further validation, this reduces the start up time when issuing the sequence to the device.

C Sample Programs

C.1 Serial Dilution

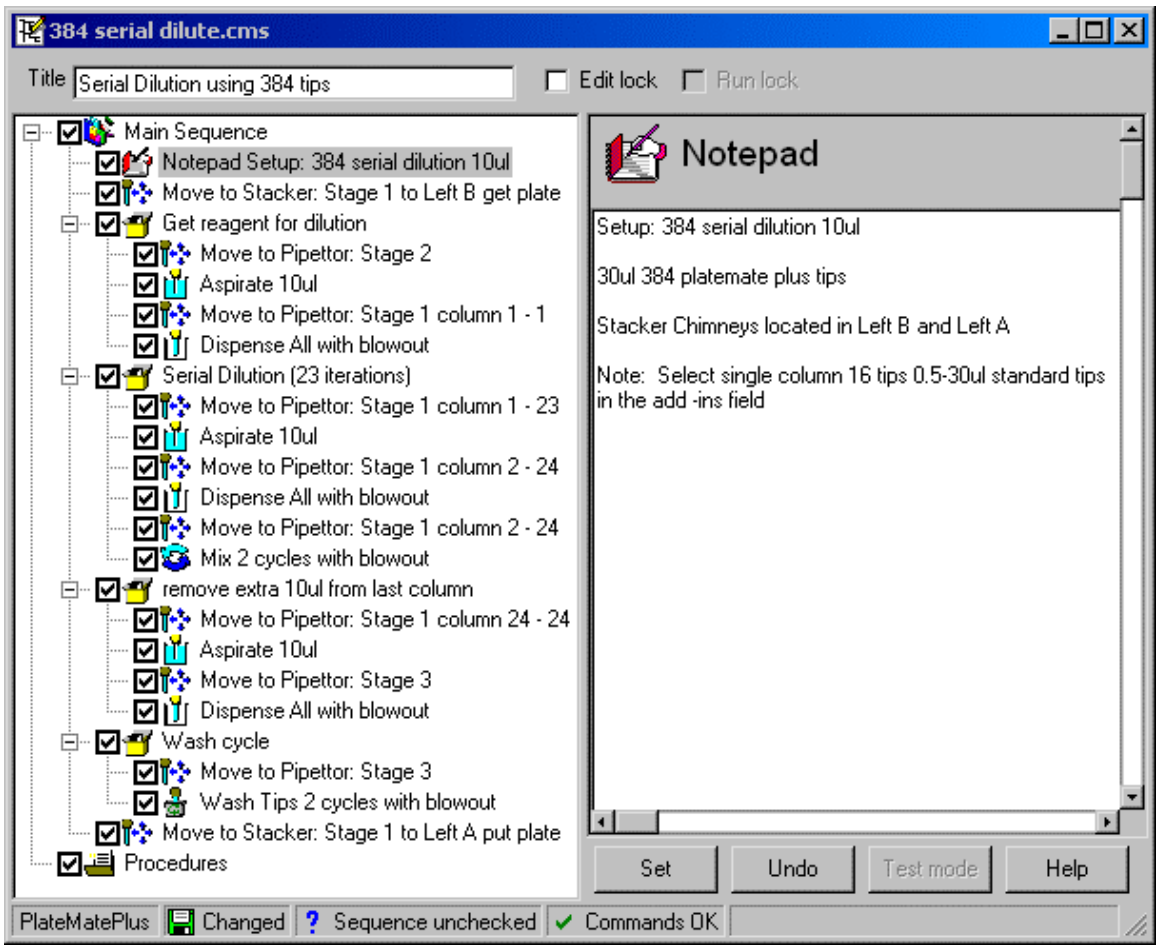


Figure 27: ControlMate Program for Serial Dilution

Sequence File Contents
File : 384 serial dilute.cms
Path : C:\Documents and Settings\Administrator\Desktop\Matrix2001\ControlMate programs\samples

```
Title     : Serial Dilution using 384 tips
Last Run  :       Duration :  (hh:mm:ss)
Edit Lock : No
Run Lock  : No

Main Sequence (MAINSEQUENCE.1)
------------------------------
  Selected : True
  Notepad (NOTE.3)
  ----------------
          Selected : True
          Text : Setup: 384 serial dilution 10ul

30ul 384 platemate plus tips

Stacker Chimneys located in Left B and Left A

Note:  Select single column 16 tips 0.5-30ul standard tips
in the add -ins field
  Move to Position (MOVE.4)
  -------------------------
          Selected : True
          Vessel type : 384 Square well flat (4310-4324)
          Position : Stacker: Stage 1 to Left B
          Height : Preset : Yes
          Tip/well offset : Preset : 1
          Height : Specific : No
          Height (1/100 mm) : 9420
          Get plate : Yes
          Loosen joined plates : No
          Put plate : No
          Tip/well offset : Quadrant : 1
          Tip/well offset : Tip/well offset : No
          Tip/well offset : Predefined : Yes
          Tip/well offset : Tip/well offset Predefined : 7
          Tip/well offset : Specific : No
          Tip/well offset : Specific X (1/100 mm) : 0
          Tip/well offset : Specific Y (1/100 mm) : 0
          Column : No
          Column : Start : 1
          Column : End : 1
          Column : Increment : 1
          Fill reservoir : No
          Fill reservoir : Until filled : Yes
          Fill reservoir : Fill time : No
          Fill reservoir : Fill time (1/100 seconds) : 0
          Read barcode : No
  Group Commands (REPEATLOOP.13)
  ------------------------------
                  Read barcode : No
```

ControlMate

Page 1

Figure 28: ControlMate Printout (page 1 only) for Serial Dilution

C.2 Neat Dispense from Reservoir

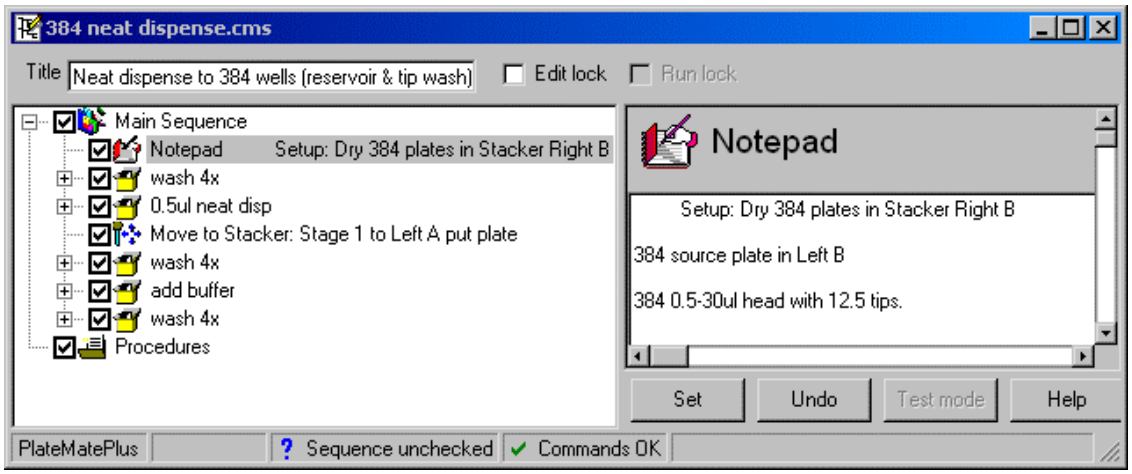


Figure 29: ControlMate Program for Neat Dispense

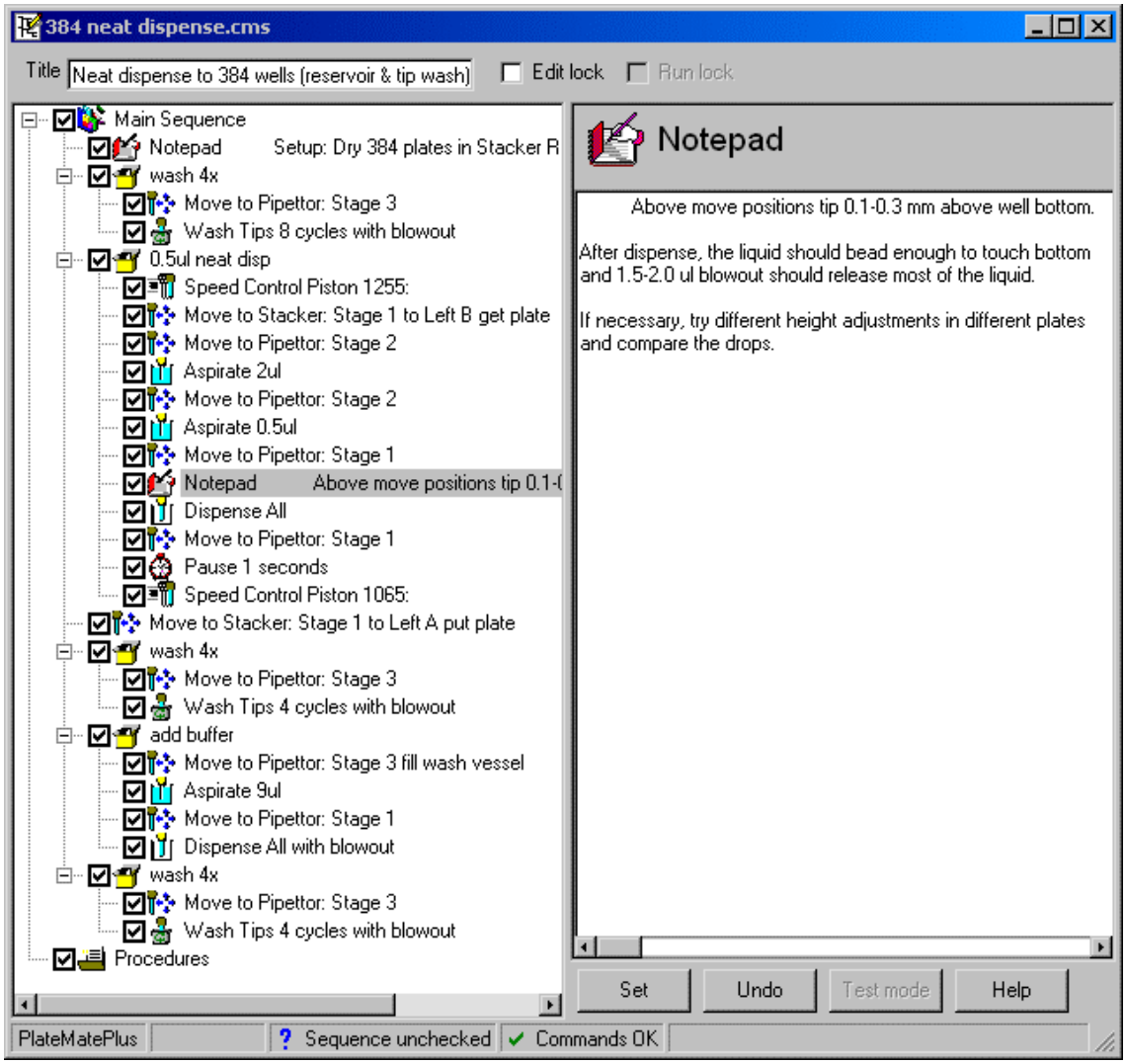


Figure 30: Neat Dispense Program: All Steps Expanded

Sequence File Contents
File : 384 neat dispense.cms
Path : C:\Documents and Settings\Administrator\Desktop\Matrix2001\ControlMate programs\samples

```
Title     : Neat dispense to 384 wells (reservoir & tip wash)
Last Run  :       Duration :  (hh:mm:ss)
Edit Lock : No
Run Lock  : No

Main Sequence (MAINSEQUENCE.1)
------------------------------
  Selected : True
  Notepad (NOTE.27)
  -----------------
          Selected : True
          Text :          Setup: Dry 384 plates in Stacker Right B

384 source plate in Left B

384 0.5-30ul head with 12.5 tips.



  Group Commands (REPEATLOOP.40)
  ------------------------------
          Selected : True
          Title : wash 4x
          iterations : 1
          Move to Position (MOVE.41)
          --------------------------
                  Selected : True
                  Vessel type : Tip wash 384 well
                  Position : Pipettor: Stage 3
                  Height : Preset : Yes
                  Tip/well offset : Preset : 1
                  Height : Specific : No
                  Height (1/100 mm) : 7400
                  Get plate : Yes
                  Loosen joined plates : No
                  Put plate : No
                  Tip/well offset : Quadrant : 1
                  Tip/well offset : Tip/well offset : No
                  Tip/well offset : Predefined : Yes
                  Tip/well offset : Tip/well offset Predefined : 1
                  Tip/well offset : Specific : No
                  Tip/well offset : Specific X (1/100 mm) : 0
                  Tip/well offset : Specific Y (1/100 mm) : 0
                  Column : No
                  Column : Start : 1
                  Column : End : 1
                  Column : Increment : 1
                  Fill reservoir : No
                  Fill reservoir : Until filled : Yes
                  Fill reservoir : Fill time : No
                  Fill reservoir : Fill time (1/100 seconds) : 0
                  Read barcode : No
          Wash Tips (WASHTIPS.42)
          -----------------------
                  Selected : True
                  Cycles : 8
                  Volume (ul) : 12
                  Blow out : Yes
                  Blow out Volume (ul) : 4
  Group Commands (REPEATLOOP.5)
  -----------------------------
          Selected : True
          Title : 0.5ul neat disp
          iterations : 1
          Speed Control (SPEEDCONTROL.15)
          -------------------------------
                  Selected : True
                  Piston : Yes
                  1 - 100% : 1255
                  Vertical : No
                  1 - 100% : 1010
                  FrontToBack : No
                  1 - 100% : 1032
                  LeftToRight : No
                  1 - 100% : 1022
          Move to Position (MOVE.28)
          --------------------------
                  Selected : True
                  Vessel type : 384 Square well flat (4310-4324)
```

Figure 31: ControlMate Printout (page 1 only) for Neat Dispense

C.3 Plate-to-Plate Transfer

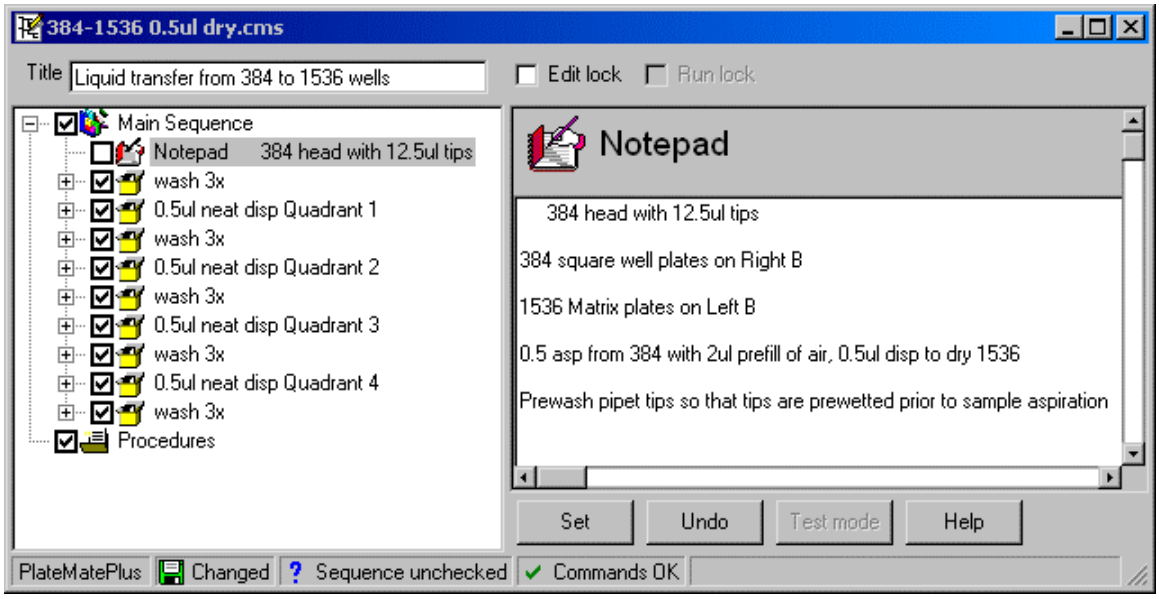


Figure 32: ControlMate Program for Plate-to-Plate Transfer

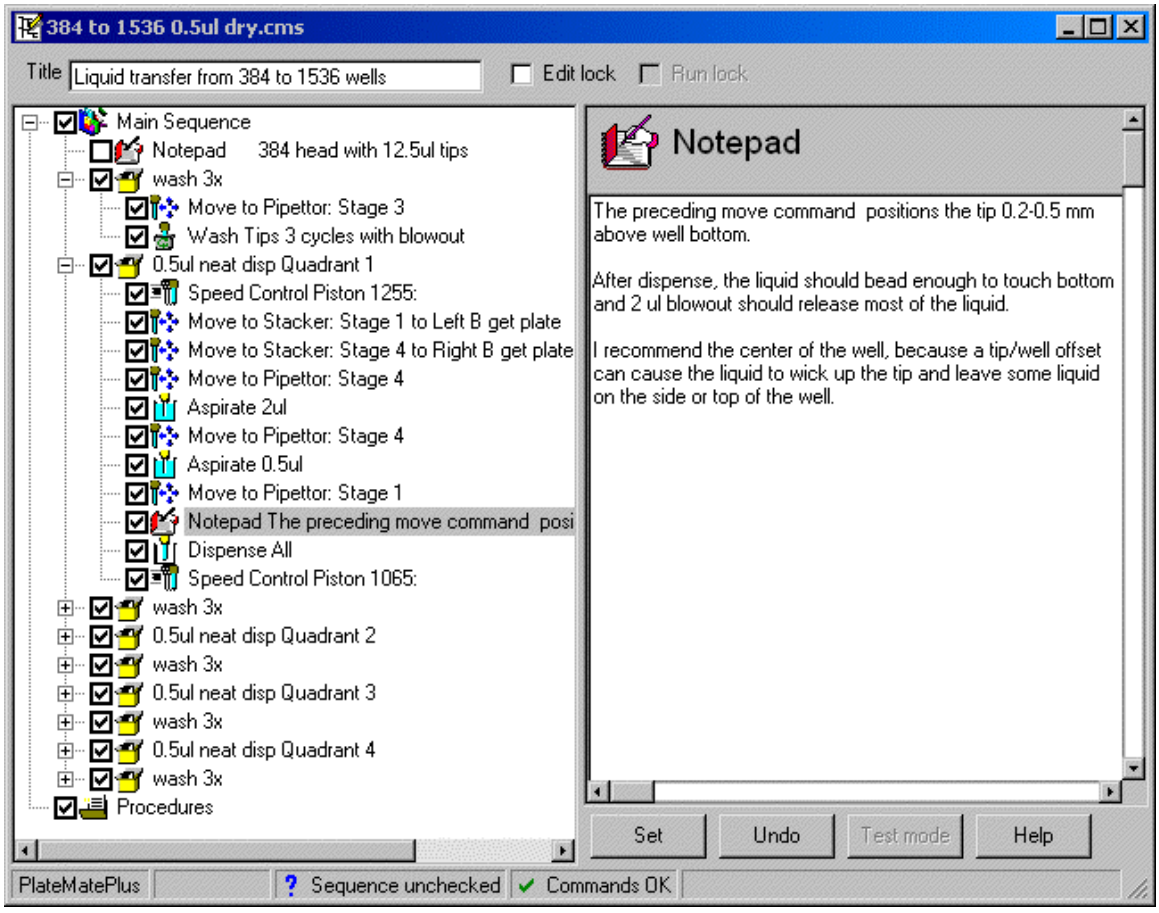


Figure 33: Plate-to-Plate Transfer Program: Wash and Dispense Steps Expanded

Sequence File Contents
File : 384 to 1536 0.5ul dry.cms
Path : C:\Documents and Settings\Administrator\Desktop\Matrix2001\ControlMate programs\samples

```
Title      : Liquid transfer from 384 to 1536 wells
Last Run   :       Duration :   (hh:mm:ss)
Edit Lock  : No
Run Lock   : No

Main Sequence (MAINSEQUENCE.1)
------------------------------
  Selected : True
  Notepad (NOTE.73)
  -----------------
          Selected : True
          Text :      384 head with 12.5ul tips

384 square well plates on Right B

1536 Matrix plates on Left B

0.5 asp from 384 with 2ul prefill of air, 0.5ul disp to dry 1536

Prewash pipet tips so that tips are prewetted prior to sample aspiration

  Group Commands (REPEATLOOP.112)
  -------------------------------
          Selected : True
          Title : wash 3x
          iterations : 1
          Move to Position (MOVE.113)
          ---------------------------
                  Selected : True
                  Vessel type : Tip wash 384 well
                  Position : Pipettor: Stage 3
                  Height : Preset : Yes
                  Tip/well offset : Preset : 1
                  Height : Specific : No
                  Height (1/100 mm) : 7400
                  Get plate : Yes
                  Loosen joined plates : No
                  Put plate : No
                  Tip/well offset : Quadrant : 1
                  Tip/well offset : Tip/well offset : No
                  Tip/well offset : Predefined : Yes
                  Tip/well offset : Tip/well offset Predefined : 1
                  Tip/well offset : Specific : No
                  Tip/well offset : Specific X (1/100 mm) : 0
                  Tip/well offset : Specific Y (1/100 mm) : 0
                  Column : No
                  Column : Start : 1
                  Column : End : 1
                  Column : Increment : 1
                  Fill reservoir : No
                  Fill reservoir : Until filled : Yes
                  Fill reservoir : Fill time : No
                  Fill reservoir : Fill time (1/100 seconds) : 0
                  Read barcode : No
          Wash Tips (WASHTIPS.114)
          ------------------------
                  Selected : True
                  Cycles : 3
                  Volume (ul) : 11
                  Blow out : Yes
                  Blow out Volume (ul) : 3
  Group Commands (REPEATLOOP.5)
  -----------------------------
          Selected : True
          Title : 0.5ul neat disp Quadrant 1
          iterations : 1
          Speed Control (SPEEDCONTROL.15)
          -------------------------------
                  Selected : True
                  Piston : Yes
                  1 - 100% : 1255
                  Vertical : No
                  1 - 100% : 1010
                  FrontToBack : No
                  1 - 100% : 1032
                  LeftToRight : No
                  1 - 100% : 1022
          Move to Position (MOVE.6)
          -------------------------
                  Selected : True
```

Figure 34: ControlMate Printout (page 1 only) for Plate-to-Plate Transfer

D Precision Data

D.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	16
1362	1317	1405	1369	1365	1028	1229	1165	1410	1278	1200	1305	1269	1351	1257	1223
1372	1305	1216	1324	1181	1372	1261	1286	1187	1177	1411	934	1305	1333	1209	1412
1451	1371	1274	1287	1344	1266	1200	1419	1345	1228	1121	1265	1289	1364	1337	1186
1426	1478	1365	1256	1389	1400	1186	1324	1335	1485	1309	1255	1294	1312	1406	1312
1344	1375	1394	1310	1366	1355	1331	1283	1342	1452	1300	1333	1296	1415	1330	1233
1442	1444	1310	1337	1335	1316	1365	1204	1283	1331	1185	1339	1392	1215	1362	1363
1381	1427	1307	1382	1323	729	1286	1289	955	1011	1223	1277	1315	1326	1266	1279
1433	1389	1406	1259	1304	1358	1403	1369	1385	1401	1405	1348	1331	1388	1397	1384
1329	1323	1444	1207	1363	1356	1245	1232	1209	1068	1307	1239	1323	1288	1211	1298
1371	1312	1375	1370	1296	1364	1350	1209	1300	1391	1260	1260	1227	1246	1486	1329
1228	1361	1375	1287	1400	1370	1211	1193	1258	1422	1292	1285	1223	1335	1261	1239
1303	1414	1310	1266	1404	1244	1312	1245	1249	1400	1228	1241	1263	1315	1283	1441
1285	1410	1317	1242	1255	1202	1019	1330	1424	1286	1219	1290	1191	1242	1310	857
1294	1402	1224	1242	1370	1328	1188	1285	1351	1228	1242	1311	1311	1291	1413	1316
1277	1412	1227	1305	1249	1247	1264	1050	1311	1187	1260	993	1387	1428	1360	1339
1228	1325	1354	1377	1204	1331	1210	1256	1373	1440	1211	1256	1320	1376	1204	1353

ə1 no blow tip touch

1303.531 **Plate SD** **95.5431** **Plate CV** **7.3%**

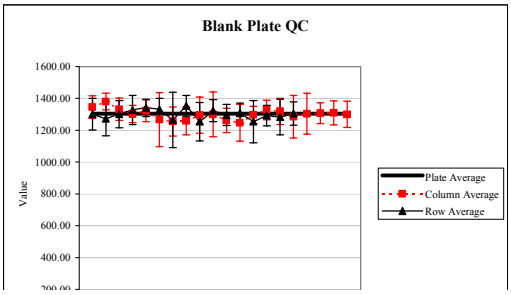
Stats calculated from Control Wells Only

Column average	Column SD	Column CV	Row Average	Row SD	Row CV	Plate average
1345.38	72.19	5.37%	1300.70	99.47	7.65%	1303.53
1379.06	51.96	3.77%	1271.85	107.78	8.47%	1303.53
1331.44	70.14	5.27%	1301.40	85.77	6.59%	1303.53
1301.25	54.68	4.20%	1327.20	91.54	6.90%	1303.53
1321.75	68.48	5.18%	1340.70	54.46	4.06%	1303.53
1266.63	170.22	13.44%	1330.95	68.65	5.16%	1303.53
1253.75	91.58	7.30%	1263.80	173.90	13.76%	1303.53
1258.69	86.86	6.90%	1353.30	66.19	4.89%	1303.53
1294.81	113.16	8.74%	1253.65	120.29	9.59%	1303.53
1299.06	140.84	10.84%	1323.00	69.61	5.26%	1303.53
1260.81	75.89	6.02%	1295.70	66.00	5.09%	1303.53
1245.69	115.73	9.29%	1307.15	63.22	4.84%	1303.53
1296.00	53.96	4.16%	1253.50	132.26	10.55%	1303.53
1326.56	60.90	4.59%	1292.05	64.63	5.00%	1303.53
1318.25	82.76	6.28%	1282.55	112.05	8.74%	1303.53
1285.25	134.01	10.43%	1304.35	73.36	5.62%	1303.53
1302.81	128.69	9.88%			#DIV/0!	1303.53
1306.63	65.86	5.04%			#DIV/0!	1303.53
1308.69	75.86	5.80%			#DIV/0!	1303.53
1299.81	82.41	6.34%			#DIV/0!	1303.53

	Value
High Control	1292.81
High Control SD	84.39
Low Control	1348.41
Low Control SD	67.69
Signal window	-6.69
Z'	9.21
Signal/Noise	-0.51
Signal/Background	0.96
Whole Plate Max value	1486
Whole Plate Min value	729

3xSD	253.171743
mean+3SD	**1545.98**
Mean-3SD	**1039.64**

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



D.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	16
A	1957	2287	2001	1887	2057	1978	2101	2102	2022	1997	1931	2069	2086	1683	2086	1839
B	1908	1812	1792	1886	2003	2112	2007	1902	1862	1963	1910	1931	2147	2099	1880	1799
C	1790	1934	1902	1768	1870	1861	1761	1908	1974	2087	1832	1783	1896	1830	2034	1940
D	1998	1849	1955	1813	2026	1952	1641	2134	2003	1946	1980	2118	2048	2055	1954	1964
E	1836	1851	2133	2035	2035	2042	2011	2021	2175	2041	2080	2113	1986	2003	2083	1982
F	1878	2063	2019	2086	2042	2115	2036	1978	2010	2180	2094	2026	2073	1981	1971	2005
G	1993	1991	2000	2109	2126	2024	2028	1931	1998	2088	2022	1823	2100	2035	2072	2056
H	1967	2016	2077	1906	2124	1994	1977	2041	1985	2046	2107	2019	2195	1945	1961	2120
I	1911	1950	2128	1925	1964	2153	1871	2047	2022	2046	1856	2082	2035	2015	1984	1954
J	1857	1931	2039	1873	1913	2005	1817	1952	1987	2035	1943	2051	1919	2020	1974	2049
K	1755	1906	1785	1997	1954	1947	1921	1703	2159	1950	1956	1934	1854	2113	2015	1878
L	1796	1890	1911	1974	1875	2148	1707	1718	2031	1911	1940	1951	1953	1980	1840	1948
M	2076	1848	2049	1877	1931	2023	1931	1951	2095	2116	2064	1942	2027	1965	2086	2193
N	1997	1958	2008	1964	2008	1903	1942	1916	1915	1979	2064	2075	1908	2175	2031	2012
O	1883	2014	1959	1990	1847	1850	1863	2026	2149	2092	1981	1889	1981	2047	1926	2111
P	1976	2007	1949	1981	1986	1997	1963	1882	2035	1898	2172	1922	2089	2182	1926	1917

Volume = 1.0ul

Plate average **1996.46** Plate SD **105.057** **Plate CV 5.26%**

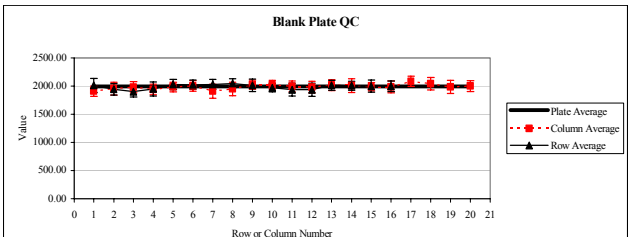
Stats calculated from Control Wells Only

Column or Row	Column average	Column SD	Column CV	Row Average	Row SD	Row CV	Plate average
1	1911.13	89.82	4.70%	2013.15	124.50	6.18%	1996.46
2	1956.69	113.92	5.82%	1946.60	102.32	5.26%	1996.46
3	1981.69	100.77	5.08%	1902.00	96.53	5.08%	1996.46
4	1941.94	92.84	4.78%	1950.70	126.86	6.50%	1996.46
5	1985.06	84.28	4.25%	2030.70	90.88	4.48%	1996.46
6	2006.50	93.16	4.64%	2025.00	82.23	4.06%	1996.46
7	1911.06	127.25	6.66%	2031.45	87.26	4.30%	1996.46
8	1950.75	118.68	6.08%	2047.50	81.89	4.00%	1996.46
9	2026.38	84.30	4.16%	2014.70	112.49	5.58%	1996.46
10	2023.44	78.97	3.90%	1972.05	72.24	3.66%	1996.46
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

	Value
High Control	2030.63
High Control SD	93.43
Low Control	2014.66
Low Control SD	83.19
Signal window	-5.81
Z'	-32.18
Signal/Noise	0.13
Signal/Background	1.01
Whole Plate Max value	2287
Whole Plate Min value	1641

3xSD	280.287862
mean+3SD	2310.91
Mean-3SD	1750.34

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



D.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 **4877.84** **Plate SD** 208.779 **Plate C.V.** 4.28%

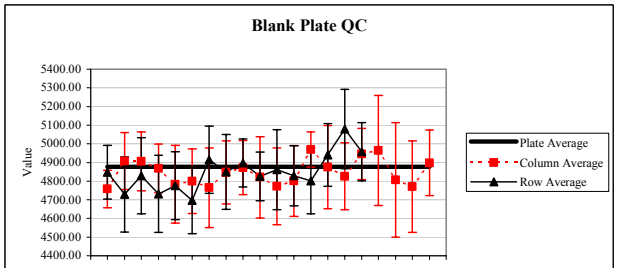
Stats calculated from Control Wells Only

Column or Row	Column average	Column SD	Column CV	Row Average	Row SD	Row CV	Plate average
1	4758.06	101.07	2.12%	4847.90	144.00	2.97%	4877.84
2	4908.06	153.30	3.12%	4728.90	201.30	4.26%	4877.84
3	4905.81	158.17	3.22%	4829.30	204.75	4.24%	4877.84
4	4868.63	129.53	2.66%	4731.65	207.02	4.38%	4877.84
5	4783.50	208.05	4.35%	4775.55	181.33	3.80%	4877.84
6	4799.94	172.99	3.60%	4698.05	180.66	3.85%	4877.84
7	4765.00	213.24	4.48%	4914.70	179.54	3.65%	4877.84
8	4847.13	169.21	3.49%	4848.95	200.86	4.14%	4877.84
9	4872.38	144.09	2.96%	4897.40	128.40	2.62%	4877.84
10	4821.13	217.46	4.51%	4825.40	131.05	2.72%	4877.84
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	4981.56	1347.78	27.06%				4877.84
23	5153.81	1348.01	26.16%				4877.84
24	5020.00	1413.70	28.16%				4877.84

	Value
High Control	5027.42
High Control SD	191.49
Low Control	5086.91
Low Control SD	156.79
Signal window	-6.31
Z'	18.56
Signal/Noise	-0.24
Signal/Background	0.99
Whole Plate Max value	5606
Whole Plate Min value	4332

3xSD	574.47139
mean+3SD	**5601.89**
Mean-3SD	**4452.95**

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



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

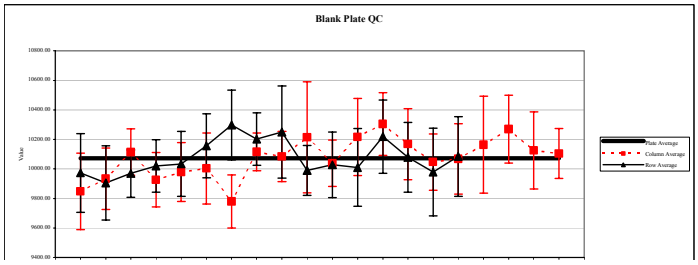
Volume = 5.0ul

Plate average **10072.94** **Plate SD** 253.668 **Plate 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
1	9847.56	259.77	2.64%	9973.15	266.96	2.68%	10072.94
2	9933.00	208.43	2.10%	9905.85	252.10	2.54%	10072.94
3	10114.31	157.19	1.55%	9969.10	161.03	1.62%	10072.94
4	9926.44	183.60	1.85%	10020.85	178.08	1.78%	10072.94
5	9978.56	199.48	2.00%	10034.20	219.30	2.19%	10072.94
6	10003.13	240.59	2.41%	10156.95	218.11	2.15%	10072.94
7	9779.25	179.36	1.83%	10297.60	237.24	2.30%	10072.94
8	10115.44	128.00	1.27%	10202.25	177.10	1.74%	10072.94
9	10084.06	170.59	1.69%	10250.05	312.09	3.04%	10072.94
10	10214.50	377.46	3.70%	9990.65	169.83	1.70%	10072.94
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

	Value	
High Control	10062.16	3xSD
High Control SD	235.72	mean+3SD
Low Control	10059.69	Mean-3SD
Low Control SD	278.03	
Signal window	-5.97	To find values outs
Z'	-623.31	control wells pres
Signal/Noise	0.01	
Signal/Background	1.00	
Whole Plate Max value	11056	
Whole Plate Min value	9361	



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