AquaMax® 2000/4000
Microplate Washer

User Guide

Molecular
Devices

Contents

Foreword

Who This User Guide Is For

This guide is intended for users of the AquaMax® 2000 and AquaMax 4000 Microplate Washers. The user guide contains setup, operation, and general maintenance information.

Conventions

Within the scope of this user guide, the following typographical conventions are used:

WARNING! A warning indicates an operation that can cause personal injury if precautions are not followed.

CAUTION! Indicates an operation that might cause damage to the instrument, device, or data, if the precautions are not followed.

Note: Emphasizes significant information in a procedure or description.

Tip: Provides useful information or shortcuts, but is not essential to the completion of a procedure.

Introduction

The AquaMax® Microplate Washers from Molecular Devices can be easily configured to meet your current application requirements. The modular design provides affordable upgrade options when your lab requirements change.

Instrument Features

AquaMax 2000 and AquaMax 4000 Microplate Washers can be configured to process 96-well and 384-well microplates used in both biochemical and cell-based assays.

- Wash heads are available in 96-well and 384-well configurations for both plate wash and cell wash.
- All wash heads are interchangeable. The software automatically detects which wash head is installed.
- The AquaMax Microplate Washer primes, cleans, and rinses the wash heads with the touch of a single button.
- The AquaMax Microplate Washer processes all plate wells simultaneously during dispense, aspirate, and wash operations.
- Whole-well dispensing and aspiration in 384-well plates result in 2 to 4 times faster plate processing than other commercially available plate washers.
- The AquaMax Microplate Washer supports most microplate formats through its user-definable plate library. Up to 32 plate types can be stored in the plate library.
- The AquaMax Microplate Washer is equipped with two (AquaMax 2000 washer) or four (AquaMax 4000 washer) reagent ports to connect 2 or 4 different dispense bottles. Waste can be drained into any waste bottle. Non-toxic waste can be drained directly into a sink. The AquaMax Microplate Washer supports 4 L or 10 L bottles only.
- All washer operations are controlled through an on-board touch-screen user interface.
- The program library can store up to 3 factory-defined and 100 user-defined programs. Each program can contain up to 50 steps.

Robot and Stacker Compatibility

AquaMax Microplate Washers are compatible with Molecular Devices StakMax® Microplate Handling System. Third party robots can be set up to control the AquaMax Microplate Washers through a USB command interface. The USB command interface is detailed in .
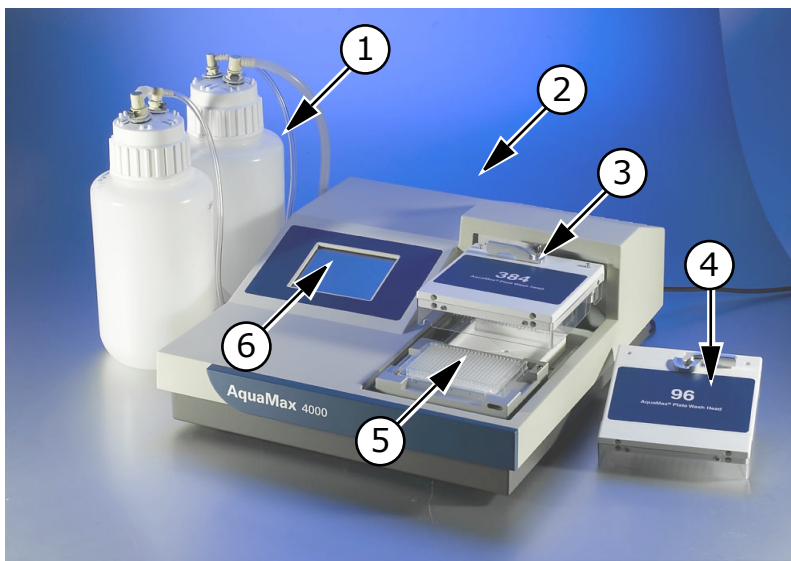
Components

Table 1-1: AquaMax® 4000 Components

Item	Description
1	4L reagent reservoirs
2	Back panel with USB and StakMax connectors
3	384-well wash head installed
4	96-well wash head
5	Microplate carriage with microplate
6	Touch screen

Touch Screen

Figure 1-1: AquaMax® touch screen

Instrument operation is controlled through a touch-screen user interface. The touch screen displays instrument status, provides access to instrument settings and programs, and controls the optional StakMax Plate Stacker.

Wash Heads

AquaMax wash heads have either 96 or 384 paired probes. The longer probe of each pair is used for aspiration. The short probe is used for dispensing. The plate wash heads have straight dispense probes and are intended for thorough cleaning and aspiration. The cell wash heads have angled dispense probes to minimize cell loss during washing.

The wash heads are interchangeable and can be removed and re-attached using a simple lever mechanism.
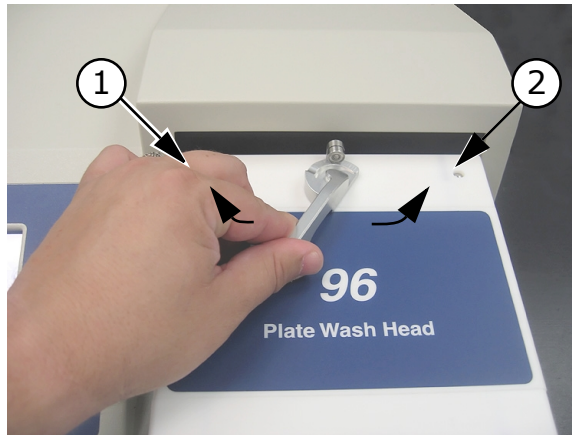
Table 1-2: 96-plate wash head lock

Item	Description
1	Close
2	Open

Note: A mismatched wash head and microplate will cause a motor pinch error when the wash head tries to descend toward the wells. A mismatch should not damage the wash head.

Each wash head has a clear plastic guard to protect the probes from damage, and to prevent spills, sprays, and injury to users.
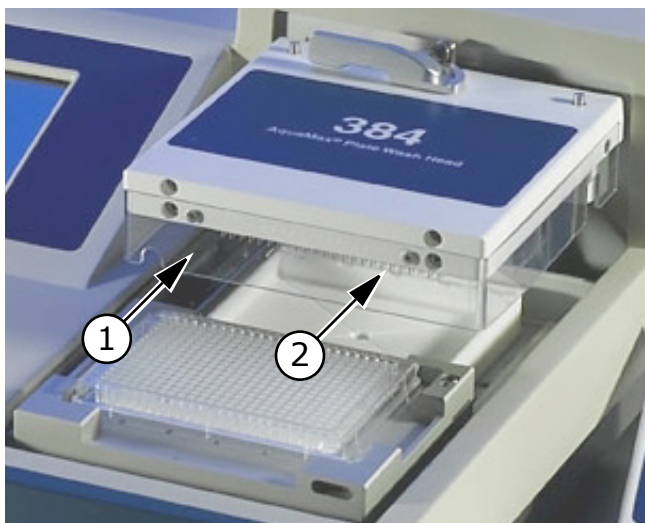
Table 1-3: 384-plate wash head and guard

Item	Description
1	Plastic guard
2	Aspiration and dispensing probes on underside of wash head

Microplate Carriage

The microplate carriage is located on the right side of the washer. The plate carriage slides in and out of the washing chamber for loading and unloading.
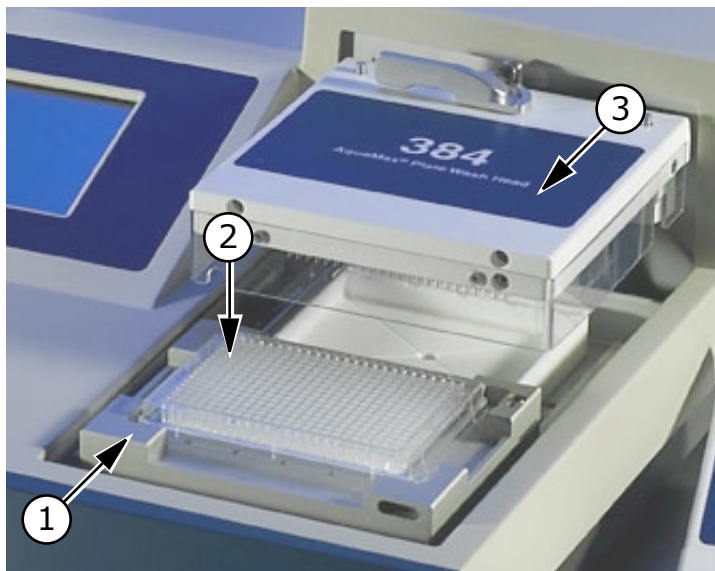
Table 1-4: Plate carriage

Item	Description
1	Plate carriage, in eject position
2	384-well microplate
3	384 wash head

CAUTION! Do not obstruct the movement of the plate carriage during operation. Obstruction can damage the instrument.

Supported Microplates

AquaMax Microplate Washers accommodate rigid SBS-standard polystyrene and polypropylene microplates with dimensions 128.2 mm (L) × 86.0 mm (W), and heights ranging from 13.5 mm to 15.5 mm, including:

- 96-well and 384-well standard formats (U-bottom, V-bottom, or Flat)
- 96-well half area
- 96-well and 384-well small volume

Note: Some microplates with conical or tapered wells and some small volume microplates are not compatible with bottom wash and aspirate operations.

Note: 96-well "strip plates" fall outside SBS guidelines, and compatibility of these plates with the AquaMax Microplate Washer varies across brands. Plates with strips that are held firmly in a more rigid frame and have smaller tabs are generally more washer-compatible. Plates with strips that have large tabs and are held loosely in a flexible frame, such as Nunc strip plates with C8 configuration, should be avoided. If you are unsure whether a plate is compatible, consult Technical Support or your sales representative before proceeding.

The AquaMax Microplate Washer also supports magnetic bead washing using the Dexter Magnetic Technologies LifeSep magnetic bead-separator adapter plates. For more details, refer to the Dexter Magnetic Technologies website: http://www.dextermag.com/lifesep.aspx.

The plate library includes eight commonly used microplates (4 each of 96-well and 384-well):

- Corning/Costar: 96 and 384
- BD/Falcon: 96 and 384
- Greiner: 96 and 384
- Nunc/Nalgene: 96 and 384

Detailed manufacturer numbers and dimensions for these default plate types are listed in Microplate Library on page 111.

The plate library can store up to 32 plate types. For information about adding a plate type, see .

Reagent and Waste Bottle Ports

The source channels and waste connections are located on the left side of the instrument. The AquaMax 2000 Microplate Washer has two source channels, while the AquaMax 4000 Microplate Washer has four. Each source channel can be connected to a reagent bottle, and is composed of a fluid input, a pressure output, and an optional level sensor connector. Waste can be drained into any waste bottle. A waste sensor can be installed to detect a full waste bottle. Non-toxic waste can be drained directly into a sink.

The AquaMax Microplate Washer supports 4 L or 10 L bottles only.
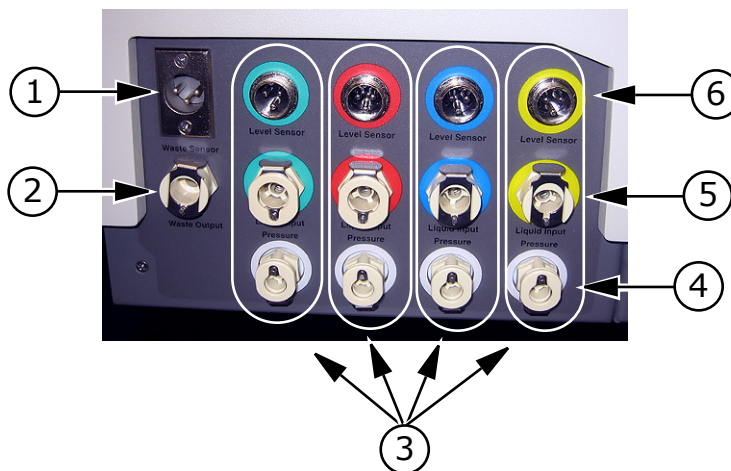
Table 1-5: Reagent ports for AquaMax® 4000 Microplate Washer.

Item	Description
1	Waste full sensor input
2	Waste fluid output
3	Source channels (green, red, blue, and yellow)*
4	Source bottle pressure outputs
5	Source bottle fluid inputs
6	Source bottle empty sensor inputs

*The AquaMax 2000 Microplate Washer has only green and red inlets.

Back Panel

The power switch, power cord receptacle, communication ports, and instrument information, are located on the back panel of the instrument.
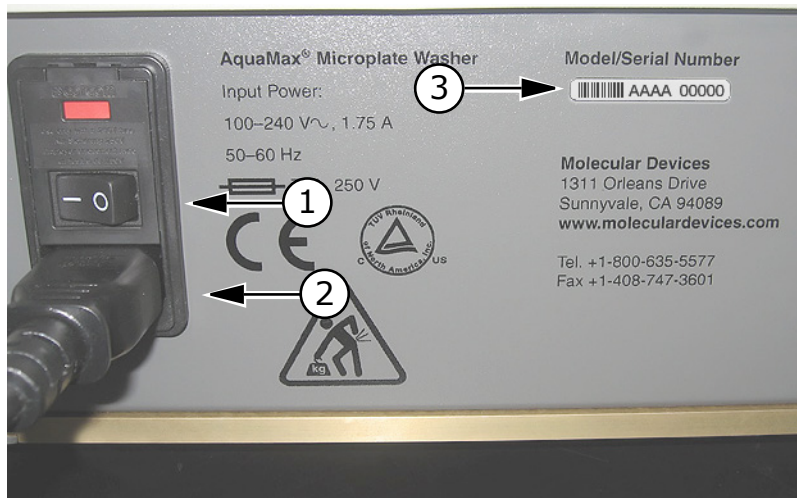
Table 1-6: Back panel, right side

Item	Description
1	Power switch
2	Power cord receptacle
3	Serial number

The power cord receptacle and power switch are located on the right side of the instrument.

Labels and text next to the power switch provide important information about the AquaMax Microplate Washer, such as line voltage rating and serial number. Use the model/serial number on this label when contacting Molecular Devices for technical support issues.

Two communication ports are located on the left side of the back panel.
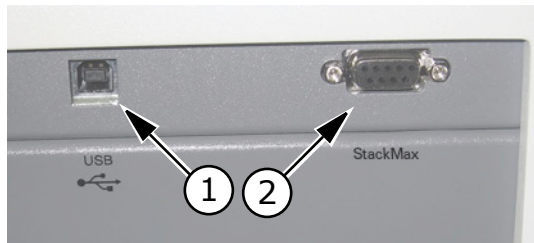
Table 1-7: AquaMax® Microplate Washer USB and StakMax® connectors

Item	Description
1	USB port
2	StakMax® connector

The USB Type B port is designated for external robotic control. The StakMax communication port is dedicated to control StakMax stacker operations. The StakMax control cable is available with the StakMax integration kit (Part Number: 0310-5454).

Installation

WARNING! Shock Hazard. To avoid electrical shock, always make sure the power switch is in the OFF position, and the power cord is removed, before installing or moving the instrument.

WARNING! Risk of fire, explosion, or shock. Do not operate the instrument in an environment where potentially damaging liquids or gases are present.

CAUTION! Do not operate the instrument in an environment with a temperature below 15°C.

CAUTION! Do not touch or loosen any screws or parts unless specifically instructed by Molecular Devices. Doing so can cause misalignment and voids the instrument warranty.

Unpacking

> **WARNING! Each AquaMax Microplate Washer weighs approximately 41 lbs (18.5 kg) and should be lifted with care.**

The AquaMax® Microplate Washers are shipped in two specially designed containers.

- The base unit box contains the washer unit and accessories (manual, power cord, waste tube, and tubing label kit):
  - AquaMax 2000 Microplate Washer (Part Number: 0310-5363)
  - AquaMax 4000 Microplate Washer (Part Number: 0310-5227)
  - The tubing label kit contains 4×3 pieces of colored slip-on plastic spiral wraps, one group of each color, for labeling bottle connections (liquid, pressure, level sensor).
- The wash head box contains up to four wash heads, each in a clamshell container:
  - 96-Well Microplate Wash Head (Part Number: 0310-5216T)
  - 96-Well Cell Wash Head (Part Number: 0310-5217T)
  - 384-Well Microplate Wash Head (Part Number: 0310-5219T)
  - 384-Well Cell Wash Head (Part Number: 0310-5218T)

The standard AquaMax Microplate Washer unit does not include any bottles. If you have purchased bottles separately, check to make sure that all bottles and tubing are present. Each reservoir bottle should contain a cap, fluid tubing, and air tubing. The waste bottle should contain its own waste tubing.

- Reagent and waste bottles:
  - 4-Liter Reservoir without Level Sensor (Part Number: 5000801)
  - 4-Liter Reservoir with Level Sensor (Part Number: 5000802)
  - 10-Liter Reservoir (Part Number: 9000-0299)
  - 10-Liter Waste Reservoir (Part Number: 9000-0296)

The AquaMax Microplate Washer supports 4 L or 10 L bottles only.

Keep all boxes and packing materials, including the clamshell containers for the wash heads. Use the original packing materials for long-term storage of the instrument. Original packing material must be used for shipping if the unit is returned for repair.

Note: If a box has been damaged in transit, it is particularly important that you retain it for inspection by the carrier in case there has also been damage to the instrument.

Setting Up the Instrument

WARNING! Each AquaMax Microplate Washer weighs approximately 41 lbs (18.5 kg) and should be lifted with care.

Set up the instrument on a level surface, away from direct sunlight, dust, drafts, and vibrations. Complete the following procedures:

To turn on the instrument

Molecular Devices recommends that you use a surge protector between the power cord and the grounded power outlet.

1. Connect the power cord to the back panel.
2. Connect the power cord to a surge protector or grounded power outlet.

   The instrument automatically detects the voltage setting.

To connect a reagent bottle

Each reagent bottle comes with two quick-connect fittings and tubing in two sizes. The larger tubing is for fluid. The smaller tubing is for bottle pressure.

The AquaMax Microplate Washer supports 4 L or 10 L bottles only.
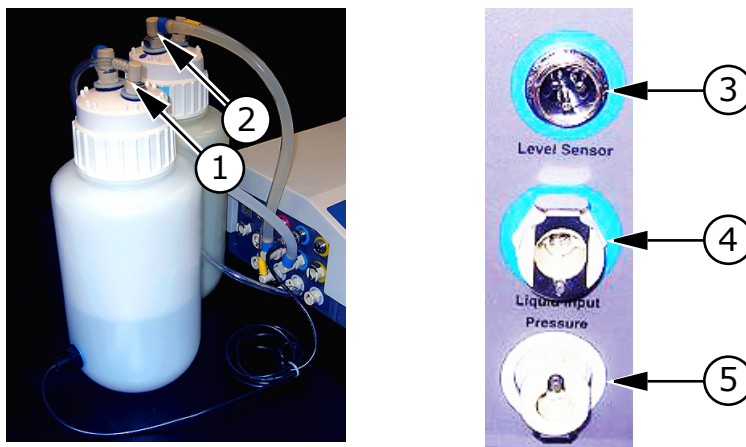
Table 2-1: Reagent bottles and connections fittings

Item	Description
1	Small fitting for pressure connection
2	Large fitting for liquid input
3	Level sensor fitting on the instrument
4	Liquid input fitting on the instrument
5	Pressure connector on the instrument

CAUTION! The source bottle and waste fluid fittings are the same size. Do not connect source bottles to the Waste Output, or damage to the instrument can occur.

CAUTION! Pressurized bottles for the AquaMax Microplate Washer provide up to 5 years of service. Eventually, they will show signs of aging such as yellowing, plastic degradation, or thread wear. Therefore, it is imperative to replace bottles at the earliest signs of aging. Use only bottles supplied for use with the AquaMax 2000 and 4000 Microplate Washers.

1. Fill the bottle with a reagent, and tighten the cap firmly.

Tip: For quick and accurate assembly of reagent bottles, use slip-on rings to color-code all tubing and sensor connections.

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2. Connect one end of the fluid tubing to the large fitting on the bottle cap.
3. Connect the other end to a Liquid Input on the left side of the instrument (green, red, blue, or yellow).

Tip: Push down on the metal fitting of the quick connector to ease the fitting into place.

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4. Connect one end of the pressure tubing to the small fitting on the bottle cap.
5. Connect the other end to the Pressure fitting below the Liquid Input.
6. If the bottle has an Empty sensor, connect the sensor to the Level Sensor connector above the Liquid Input fitting used.

To connect a waste bottle
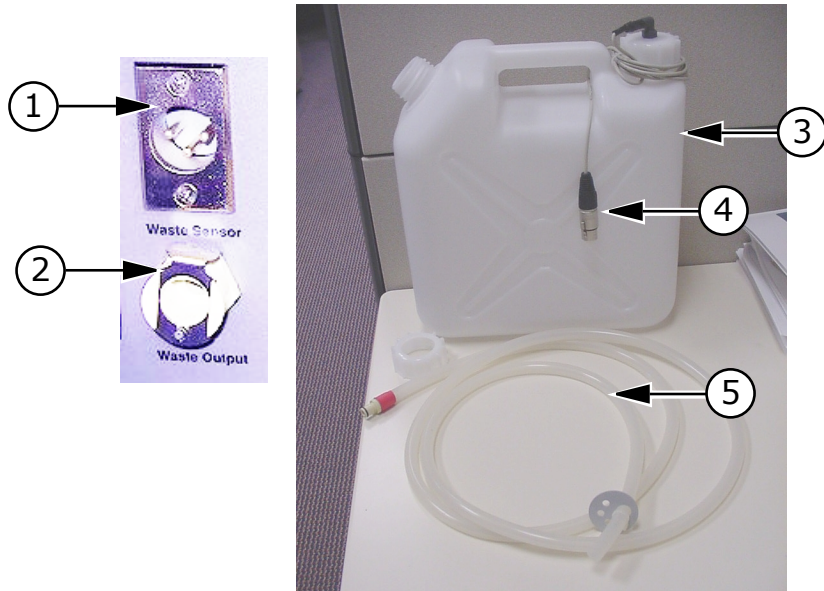
Table 2-2: Waste bottle and connection fittings

Item	Description
1	Waste sensor connector
2	Waste output fitting
3	Waste bottle
4	Waste full sensor
5	Waste tubing

1. Connect the quick connect fitting of the waste tubing to the Waste Output fitting on the left side of the instrument.

2. Connect the free end of the tubing to any vented waste container.

   For non-toxic waste the free end of the tubing can be placed directly into a sink. The open end of the waste tubing must be below the level of the Microplate Washer, and must remain free of obstruction.

   CAUTION! An obstructed waste tubing can damage the instrument.

3. If the bottle has a waste full sensor, connect the waste full sensor to the Waste Sensor input fitting.

   WARNING! Biohazard. Waste tubing must be connected during operation. Waste fluid is ejected out of the waste port. If no waste tubing is connected, waste will spray and spill from the waste output port.

   CAUTION! Waste containers must be vented. Connecting the waste tubing to a pressurized or closed vessel will cause damage to the waste pump.

To install the wash head

> ⚠️ **CAUTION!** The probes on the underside of the wash head are delicate. Take care when handling the wash heads.

1. Install the wash head (96 or 384) of choice. Wash heads are shipped pre-qualified and will work with any base unit.
2. Move the lever to the left to lock the wash head in place.

Figure 2-1: Wash head lock

3. Turn ON the instrument power switch located on the back panel.

   The following operations occur as the instrument initializes when turned on:

   - The wash head rises to prepare for plate loading.
   - The touch screen turns on and displays instrument status.
   - The plate carriage and wash head motor find home and return to eject positions.

Connecting to a StakMax® Plate Stacker
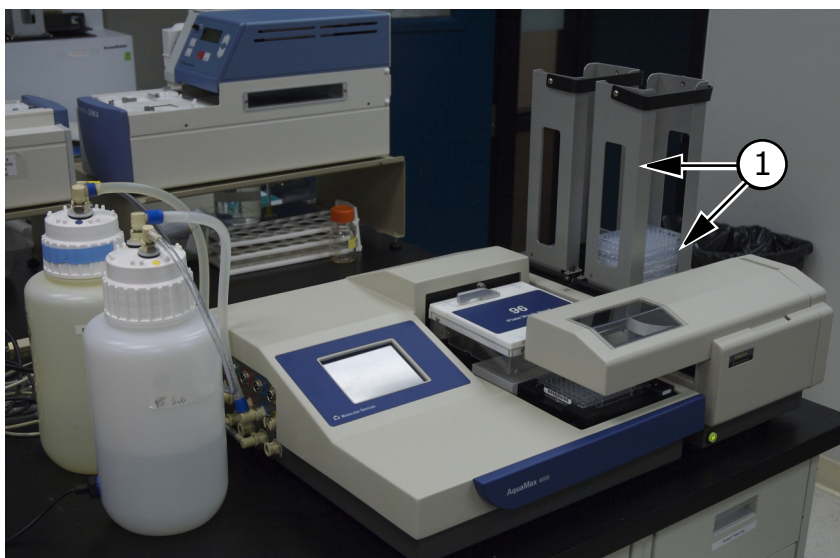
Table 2-3: AquaMax® Microplate Washer with StakMax® Plate Stacker installed

Item	Description
1	StakMax® Plate Stacker

To connect the AquaMax Microplate Washer to the StakMax® Plate Stacker you will need the StakMax integration kit (Part Number: 0310-5454). The integration kit consists of a StakMax/AquaMax base plate, bolts for the base plate, a tool for the bolts, a StakMax communication cable, and an integration manual.

To set up a StakMax® Plate Stacker with an AquaMax® Microplate Washer

For more detailed instructions, see the integration manual.

1. Make sure that both the AquaMax Microplate Washer and the StakMax Plate Stacker are turned off and that the power cords are disconnect from the power supply.

2. Use the StakMax/AquaMax base plate to connect the StakMax Plate Stacker to the AquaMax Microplate Washer (Figure 2-4).
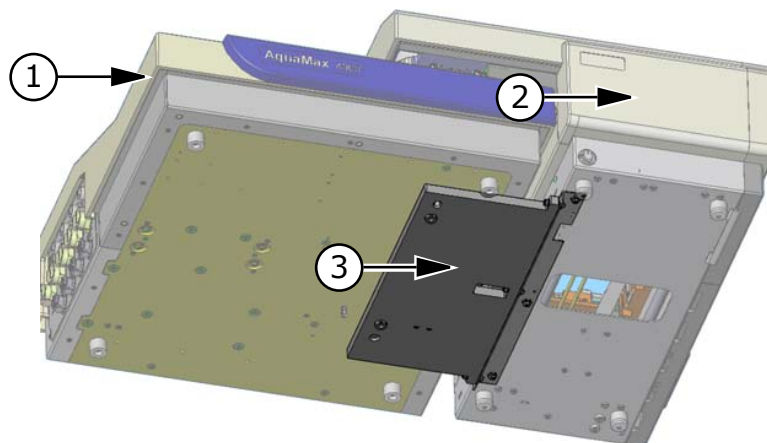
Table 2-4: StakMax® Plate Stacker to AquaMax® Microplate Washer adapter plate

Item	Description
1	AquaMax® Microplate Washer
2	StakMax® Plate Stacker
3	Adapter plate

3. Connect the StakMax communication cable to the serial port on the back of the StakMax Plate Stacker.

4. Connect the StakMax communication cable to the StakMax port on the back panel of the AquaMax Microplate Washer. See Back Panel on page 17.

5. Turn on both the AquaMax Microplate Washer and the StakMax Plate Stacker.

The StakMax Plate Stacker automatically detects that it is connected to the AquaMax Microplate Washer.

The AquaMax Microplate Washer detects the StakMax Plate Stacker.
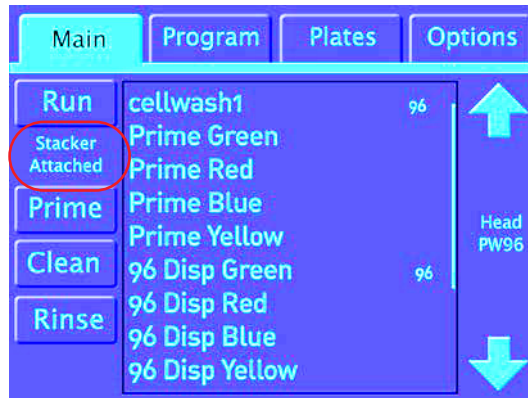
Figure 2-2: StakMax Stacker indicator

The washer controls the stacker through its on board programs. For information about using the stacker in a program, see Program Stacker Settings on page 43.

AquaMax® 2000/4000 Microplate Washer User Guide

Getting Started

<div style="text-align:right">**3**</div>

This chapter provides the information required to get started with the AquaMax® 2000 and AquaMax 4000 Microplate Washers.

Starting the Instrument

To turn on the instrument, use one of the following procedures:

- If the instrument is in shutdown mode, touch anywhere on the screen to wake the instrument up. For information about shutdown mode, see Shutdown Options Dialog on page 78.

- If the instrument has been turned off, turn ON the instrument power switch located on the back panel.

  The instrument automatically performs diagnostic checks to make sure that it is functioning correctly. When the diagnostic checks are complete, the touch screen displays the Main tab.
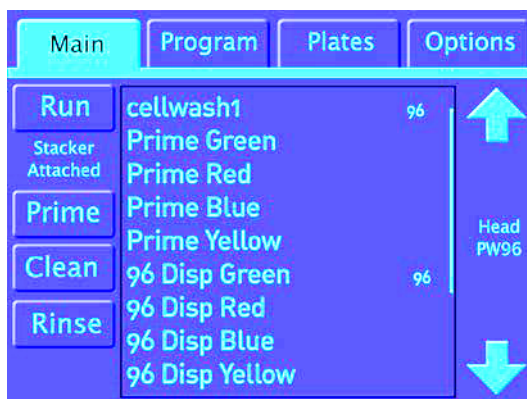
Figure 3-1: Main tab

Main Tab

The Main tab is used to execute stored programs. It features quick access buttons for the one-touch maintenance programs and a list of user-defined programs.

Table 3-1: Main tab

Item	Description
1	Function Tabs–The Main tab is selected.
2	Run–Runs the selected program in the list.
3	Stacker Attached–Indicates that the StakMax® Plate Stacker is attached.
4	Prime–Runs the one-touch prime program. The one-touch prime program performs a full prime on the wash head and internal fluidics from the default user-prompted fluid inlet.
5	Clean–Runs the one-touch cleaning program. The one-touch clean program cleans and decontaminates internal fluid paths. The system primes with the cleaning solution, pauses for 5 minutes to allow the cleaning solution to soak in the system, and follows with 3 rinse cycles using the rinse solution. The default program uses the red inlet for cleaning and the green inlet for rinsing. The system is purged at the end of this program. See Table B-1: AquaMax® Microplate Washer Compatible and Incompatible Cleaning Solutions on page 113.

Table 3-1: Main tab (cont'd)

Item	Description
6	Rinse–Runs the one-touch rinse program. The one-touch rinse program runs the standard rinse cycle three times to flush the internal fluidics with rinse solution from the default green inlet. At the end of the rinse program, the system drains the rinse solution from the fluid paths.
7	Program List–Displays a list of the user-defined programs in the program library. The number to the right of the program name (96 or 384) refers to the plate type used. • Red indicates that the program uses a plate type that has been changed since the program was last saved. When you run a red program, an error message prompts you to accept the plate parameter change before the program runs. • Gray indicates that the program is not compatible with the installed wash head. You cannot run gray programs.
8,10	Up Arrow and Down Arrow–Scroll the list if the number of programs exceeds the display area.
9	Head–Identifies the installed wash head or cell head: • **PW96**: 96-well plate wash head • **PW384**: 384-well plate wash head • **CW96**: 96-well cell wash head • **CW384**: 384-well cell wash head

Note: One-touch programs can be edited and copied like any other programs, but they cannot be renamed or deleted.

Note: Only program settings applicable to the installed wash head are available in the on-screen menus.

Running Programs

To run a stored program

Note: Gray programs are not compatible with the installed wash head. You cannot run a gray program.

Note: Red programs indicate a change in the plate type. When you run a red program, the message "Plate parameters changed" appears. Click OK to acknowledge the changes and return to the program list. The red is removed and you can run the program as usual. Click Cancel to exit the program without changing the red status indicator.

1. Make sure that all appropriate reagent bottles are connected to Liquid Input and Pressure fittings on the left side of the instrument.
2. Make sure that the waste tubing is connected to the Waste Output fitting and the Waste bottle.
3. Load the appropriate microplate in the plate carriage.
4. On the **Main** tab, touch the program from the list and touch **Run**.

   When a program is running, the touch screen displays a status dialog.

Figure 3-2: Status dialog

To run a one-touch maintenance program

1. Make sure that all appropriate reagent bottles are connected to Liquid Input and Pressure fittings on the left side of the instrument.

2. Make sure that the waste tubing is connected to the Waste Output fitting and the Waste bottle.

3. On the **Main** tab, touch the appropriate one-touch program button.

   When a program is running, the touch screen displays a status dialog. (See Figure 3-2.)

Note: For information about one-touch program defaults, see Program Tab on page 38. One-touch programs can be copied and edited.

Stopping Programs

To interrupt a program in non-emergency conditions

When you run a program, the touch screen displays a status dialog. (See Figure 3-2.)

- For non-emergency stops touch **Cancel**.

  Cancel stops the program when appropriate. It turns off the pumps, resets the wash head, moves the plate carriage to the plate load position, and performs program clean up before returning control to the touch screen.

To interrupt a program in emergency conditions

When you run a program, the touch screen displays a status dialog. (See Figure 3-2.)

1. For emergency stops touch **Stop**.

   Stop halts the program immediately. It turns off all pumps and motors, closes valves, and releases system pressure.

2. Touch **OK** to recover and remove the plate.

   A software reset is performed before returning control to the touch screen.

3. If fluid remains in the trough, then in the **Options** tab, touch **Purge**.

Note: The wash head must be re-primed to continue.

Shutting Down the Instrument

The AquaMax Microplate Washer supports the following shutdown options:

- For general use with short periods of inactivity, use Automatic Shutdown. Automatic Shutdown puts the instrument in a low power mode after a user-specified time of inactivity. It turns off the screen, releases system pressure, and shuts off all motors and valves. The shutdown process can include a rinse and purge cycle. For information about automatic shutdown options, see Shutdown Options Dialog on page 78.

- For longer periods of inactivity, for example if the instrument is not used every day, turn off the instrument. For information, see To turn off the instrument on page 93.

- For storage or shipping, rinse and purge the instrument and remove the wash head before turning off the power. For information, see To prepare the wash head for storage on page 94.

Operation: The Touch Screen Interface

4

Operation of the AquaMax® Microplate Washer is controlled by the on-board touch screen.

This chapter provides information about the functions that are available on each tab of the interface.

For information about the Main tab and about running programs, see .

Administrative Mode

The default operating mode of the touch-screen interface allows all users to access all program functions, plate functions, and options.

You can restrict access to editing functions and system options by setting an administrator passcode. (See .) After setting an administrator passcode, you must use the administrator passcode to access the following functions and options:

• New (Program, Plates)	• Copy (Program)
• Rename (Program)	• Restack (Options)
• Delete (Program, Plates)	• Change passcode (Options)
• Calibrate screen (Options)	• Shutdown options (Options)
• Edit (Program, Plates)	

You can access the restricted functions by touching the Admin button and entering the administrator passcode. There is only one passcode for the instrument, but the passcode must be entered separately on each tab.

The passcode is not required to run existing programs, view program details and plate details, or access Depressurize, Purge, and Shutdown on the Options tab.

Program Tab

The Program tab contains the functions to manage the program library.

Table 4-1: Program tab, general access to all functions

Item	Description
1	Function Tabs–The Program tab is selected.
2	New–Creates a new program.
3	Edit–Opens the selected program for review and editing.
4	Rename–Renames the selected program.
5	Copy–Copies the selected program.
6	Delete–Deletes the selected user-defined program. The one-touch programs cannot be deleted.
7	Program List–Displays a list of programs in the program library. The number to the right of a user-defined program (96 or 384) refers to the plate type used. Red indicates that the program uses a plate type that has been changed since the program was last saved.
8,11	Up Arrow and Down Arrow–Pages up and down through the program list if the list exceeds the display area.

Table 4-1: Program tab, general access to all functions (cont'd)

Item	Description
9,10	Move Up and Move down–Moves the selected program up or down in the program list. The one-touch programs cannot be moved. They are always listed at the top of the program list.

Program Tab: Administrative Mode

In administrative mode, general users have access only to the View button and the Admin button. The Admin button and the administrator passcode access the program editing options.
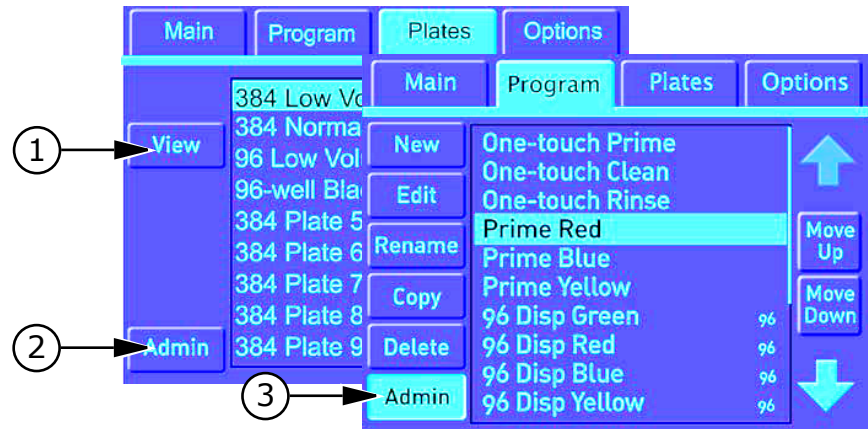
Table 4-2: Program tab with administrator passcode

Item	Description
1	View–Opens the selected program so that you can view the settings and steps.
2	Admin–Opens the passcode dialog to access the program editing options.
3	Admin–Indicates that the AquaMax® Microplate Washer is in administrator mode, and exits administrator mode when programming changes are complete.

For information about the program editing buttons, see .

For information about restricting access to editing functions, see
Restricting Functions on page 80.

Program Settings Dialog

The Program Settings dialog controls step-independent program
information. It appears automatically when you create a new program
and is the first item in the program after the program has been saved.
See To access the Program Settings dialog for a program on page 41.

Table 4-3: Program Settings

Item	Description
1	Plate–Lists the plates in the plate library. The highlighted option is the option used for the current program. Plate type is not required for programs involving only maintenance steps such as Prime, Soak, Clean, Rinse, and Standby. Select no plate for maintenance programs. Gray indicates that the plate is not compatible with the installed wash head and is not available for selection.
2	Program Options–Opens the Program Options dialog with additional program specific options.
3	Up/Down Arrows–Page through the list plates in the plate library.

Note: Program options and menus are optimized for the installed wash
head. Plate types that are not compatible with the installed wash head
are disabled.

To access the Program Settings dialog for a program

1. Touch the **Program** tab.
2. Select a program from the list.
3. Touch **Edit**.
4. Touch **Program Settings** at the top of the list of program steps.
5. Touch **Edit**.

Program Options

Access Program Options from the Program Settings dialog. Messages, stacker settings, and dispense accuracy adjustments are program specific.

Table 4-4: Program Settings

Item	Description
1	Messages–Opens the Messages dialog where you can set Program Start and Program Done messages for the current program.
2	Stacker–Opens the stacker functions dialog for the current program.
3	Adjust Dispense–Opens the Adjust Dispense dialog for the current program.

Program Messages

You can set up the program to display a message before and after running the steps of the program. Messages are optional.
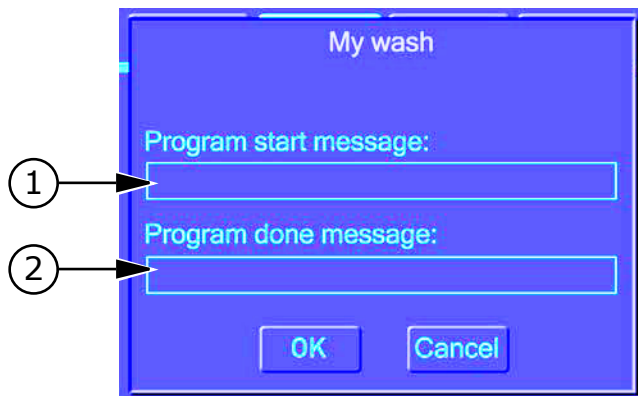
Table 4-5: Messages dialog

Item	Description
1	Program Start Message–Opens the keypad where you can enter a message to display on the touch panel when the current program is run. Running a program that has a Program Start Message defined displays the message first. The user must confirm the message before the program can run.
2	Program Done Message–Opens the keypad where you can enter a message to display on the touch panel when all the steps of the current program have been run.

To access the messages options for the current program
1. Select **Program Settings** from the list of steps.
2. Touch **Edit**.
3. Touch **Program Options**.
4. Touch **Messages**.

Program Stacker Settings

In the stacker settings dialog you can enable stacker options for the current program. Stacker settings are optional. See To access the stacker options for the current program on page 44.

With the stacker enabled, plates are supplied from the stacker input. Each plate is washed using the same program and then placed in the stacker output. The program ends when the input stack is empty.

Table 4-6: Program stacker settings

Item	Description
1	Enable Stacker–Enables and disables the plate stacker. The stacker is enabled when the button is highlighted.
2	Restack at End–Transfers the plates back to the input stack at the end of the program.

The stacker options are available when a stacker is not attached to the washer. If you run a program with the stacker functions enabled and no stacker, the washer displays a warning with instructions to add a plate manually.

To access the stacker options for the current program

1. Select **Program Settings** from the list of steps.
2. Touch **Edit**.
3. Touch **Program Options**.
4. Touch **Stacker**.

Adjust Dispense

The Adjust Dispense dialog lets you optimize the accuracy of the dispense volumes based on the specific requirements of the individual program. For more information, see To adjust dispense accuracy for a program on page 68.

Figure 4-1: Adjust dispense

Program Tab: Program Editing

The Program Tab contains the functions to manage the steps in the current program. See To access program details on page 46.

Table 4-7: Program details

Item	Description
1	New–Opens the New Step dialog where you can select the type of new step to add to the current program.
2	Edit–Opens the selected step for editing.
3	Copy–Copies the selected step.
4	Delete–Deletes the selected step.
5	Test–Runs through the steps in the current program.
6	Done–Closes the current program and returns to the list of programs.
7	Displays the name of current program.
8	Program Settings–Opens the Program Settings dialog. To view and change the details, select Program Settings and touch Edit.
9	Program Details–Lists the steps that make up the program. Details for the steps are noted to the right. To change the details, select the step and touch Edit.

To access program details

1. Touch the **Program** tab.
2. Touch a program.
3. Touch **Edit**.

New Step Selection

The New Step dialog lists the steps that can be included in the current washer program. Steps that are not compatible with the currently installed equipment options appear gray.

Each program can have up to 50 steps.

Note: Before creating or editing a program, make sure that the equipment is configured for the operations you want to program. The system detects the installed options and tailors menus and program options.

Figure 4-2: Steps that can be included in a program

The following sections detail the settings for each step type:

- Dispense Settings on page 47
- Aspirate Settings on page 49
- Wash Settings on page 50
- FastWash Settings on page 53
- Shake Settings on page 54
- Soak Settings on page 55

Dispense Settings

The Dispense step dispenses fluid into a microplate using predefined parameters. Fluid dispense occurs at the top of the wells to prevent contamination to the probes.
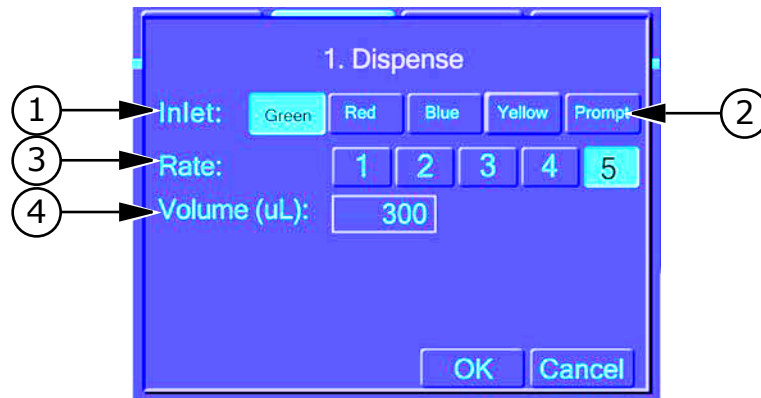
Table 4-8: Dispense settings

Item	Description
1	Inlet–Liquid to be used for this step. Available options correspond to the color-coded reagents connected to the washer.
2	Prompt–Indicates that system will pause before dispensing and wait for the user to specify the inlet.
3	Rate–Dispense rate. See Table 4-9: Plate Wash and Cell Wash Dispense Rates.

Table 4-8: Dispense settings

Item	Description
4	Volume–Volume to be dispensed. Use 5 to 150 μL for 384-well plates and 20 to 400 μL for 96-well plates. The volume must be within the specified range for the plate or the program cannot be saved or run.
	Note: You should never dispense a greater volume than is listed by the plate manufacturer.

Table 4-9: Plate Wash and Cell Wash Dispense Rates

Plate wash dispense rate	96 plate wash		384 plate wash	
	(mmHg)	**(μL/plate/sec)**	**(mmHg)**	**(μL/plate/sec)**
1	150	18300	150	21600
2	200	22100	200	25600
3	250	25400	250	26200
4	350	31300	350	35600
5	450	36600	450	41400

Cell wash dispense rate	96 cell wash		384 cell wash	
	(mmHg)	**(μL/plate/sec)**	**(mmHg)**	**(μL/plate/sec)**
1	75	7200	150	19400
2	100	9100	200	23000
3	150	12400	250	26300
4	250	17800	350	32100
5	350	22500	450	37400

Tip: Best dispense volume accuracy and precision are achieved at the highest rate (Rate 5) and volume.

Dispense accuracy is set to specification during manufacturing. The following factors can affect dispense accuracy:

- Types of reagent.
- Locations and size of reagent bottles.

    The AquaMax Microplate Washer supports 4 L or 10 L bottles only.

- Level of reagent in bottles (too full or too low).

To adjust dispense factors, see To adjust dispense accuracy for a program on page 68.

Aspirate Settings

The Aspirate step removes fluid from a microplate using predefined parameters.
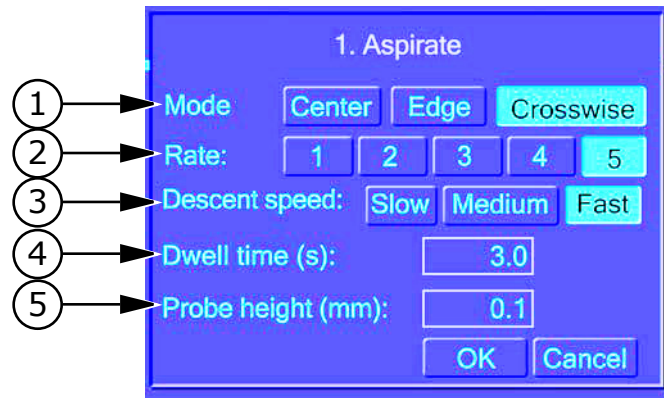
Table 4-10: Aspirate settings

Item	Description
1	Mode–Aspiration from Center, Edge, or Crosswise (from front to back of wells). Edge and Crosswise aspiration are supported for flat bottom wells only.
2	Rate–Aspiration rate. See Table 4-11: Aspiration Rates.
3	Descent speed–The speed at which the probes enter the wells.
4	Dwell time–Dwell time at the final probe position. The default value is 1 second. Range is 0-30 seconds.

Table 4-10: Aspirate settings

Item	Description
5	Probe height–final probe height above the bottom of the well. The range is 0 to the top of well. The maximum probe height is the well depth specified in the plate library.
	To avoid damage to probes and plate bottom, the AquaMax® Microplate Washer has a "no touch" feature. If the height is set to 0mm, the aspiration pins are offset from the well bottom by a minimum clearance.

Table 4-11: Aspiration Rates

AQ 4000	AQ 2000	96 (µL/well/sec)	384 (µL/well/sec)
5	Fast	270	70
4		240	60
3		200	50
2	Gentle	80	20
1		50	10

Tip: For plate washing, minimal residual volume is best achieved using Crosswise aspiration, a rate of 5, a fast descent speed, a 1 second dwell time, and 0 mm to 0.2 mm probe height.

Wash Settings

The Wash step washes a microplate using predefined parameters.

Note: To prevent overflow when using the Wash function with a plate wash head, add a surfactant such as Tween to wash solutions.

Table 4-12: Wash settings

Item	Description
1	Inlet–Liquid to be used for this step. The available options correspond to the color-coded reagents connected to the washer.
2	Prompt–Indicates that the system will pause before dispensing and wait for the user to specify an inlet.
3	Rate–Wash rate (see Table 4-13: Wash Rates). This option is available for the AquaMax® 4000 Microplate Washer only.
4	Volume–Volume of wash fluid used per well. Use 50 µL to 3000 µL.
5	Wash position–Position of aspiration probes during the wash. • Bottom: The aspiration probes aspirate to the bottom of the well, then wash with the specified amount of wash fluid at that position. Bottom washing results in partially empty wells at the end of the wash. • Top: The aspiration probes remain just below the top of the well, then wash with the specified amount of wash fluid at that position. Top washing results in full wells at the end of the wash.

Table 4-13: Wash Rates

Model #	Options	96 (µL/well/sec)	384 (µL/well/sec)
AQ 4000	Fast	270	70
	Gentle	200	60

Table 4-13: Wash Rates

Model #	Options	96 (µL/well/sec)	384 (µL/well/sec)
AQ 2000	(no option)	270	70

Tip: Wash volume should not exceed 10x the well volume.

Tip: The wash step leaves the wells partially empty (bottom wash) or full (top wash). To empty the wells, add an aspiration step.

FastWash Settings

The FastWash step is designed for rapid microplate washing using multiple aspirate-dispense cycles with predefined parameters. FastWash performs a final aspiration after the last cycle. All aspirations use a rate of 5 and a fast descent speed. See Table 4-11: Aspiration Rates.

Table 4-14: FastWash settings

Item	Description
1	Inlet–Liquid to be used for this step. The available options correspond to the color-coded reagents connected to the washer.
2	Prompt–Indicates that the system will pause before dispensing and wait for the user to specify an inlet.
3	Rate–Dispense rate. See Table 4-9: Plate Wash and Cell Wash Dispense Rates.
4	Volume–Volume of wash fluid to be dispensed per well in each cycle. Use 5 to 150 μL for 384-well plates and 20 to 400 μL for 96-well plates.
5	Cycles–Number of times the volume is dispensed.
6	Dwell Time–Duration in seconds (0 to 30) that the probe rests at the final probe position. The default value is 1 second.
7	Probe Height–Final probe height above the bottom of the well during aspiration. The range for plate wash heads is 0 mm to the top of the well.

Shake Settings

The Shake step shakes a microplate in the carriage using predefined parameters.
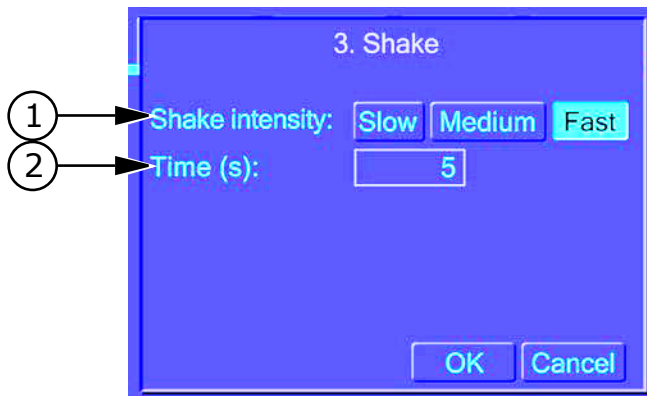
Table 4-15: Shake settings

Item	Description
1	Shake speed–Speed of shaking (Slow, Medium, or Fast). A fast shake is vigorous and generally mixes the wells in 10 to 30 seconds.
2	Time–Duration of shake. Acceptable range is 1 to 600 seconds.

Soak Settings

The Soak step pauses the program for a specified duration. During a Soak step, probes are removed from the microplate wells. No other operations are performed for the duration.
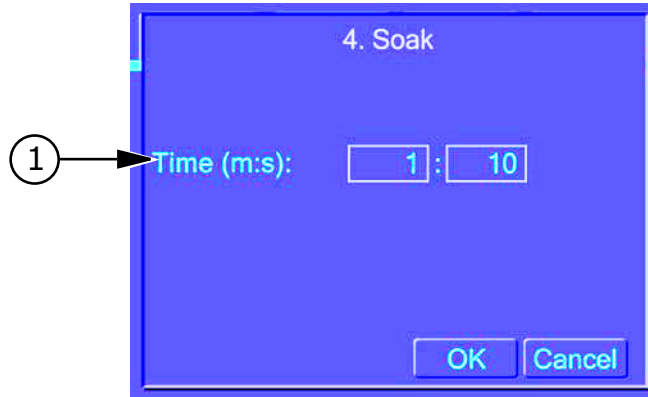
Table 4-16: Soak settings

Item	Description
1	Time–Duration of soak, in minutes and seconds. Acceptable range is 1 second to 120 minutes.

Repeat Settings

1. The Repeat step repeats a set of previous program steps.

Table 4-17: Repeat settings

Item	Description
1	Repeat from step–The numbered step at which to start the repetition. The list contains the previous steps in the current program.
2	Repetitions–The number of extra cycles to be performed. For example, setting repetitions to 5 means that the specified step would be executed once from the original program, and then repeated 5 more times in the Repeat step, for a total of 6 cycles.

Note: One Repeat step counts as just one step in the 50-step program limit, regardless of the number of steps or cycles repeated. The system will not allow a Repeat step within another Repeat step.

Purge Settings

The Purge step evacuates liquids from the installed wash head. It has no programmable parameters.
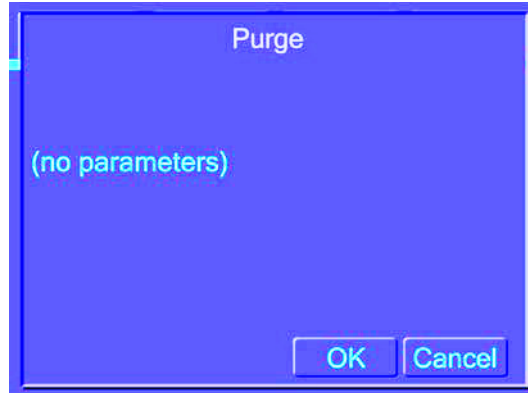
Figure 4-3: Purge screen (no settings)

✳ **Tip:** Run a Purge step when the washer will not be used again immediately. Purging prevents needle clogging or mold growth when the instrument is idle.

✳ **Tip:** Run a Purge step before removing the wash head.

Rinse Settings

The Rinse step flushes the selected reagent through the internal fluidics and the installed wash head.

Table 4-18: Rinse settings

Item	Description
1	Inlet–Liquid to be used for this step. The available options correspond to the color-coded reagents connected to the washer.
2	Prompt–Indicates that the system will pause before dispensing and wait for the user to specify an inlet.

After rinsing with a harsh reagent, such as a cleaning solution, rinse with water several times to fully remove any harmful residues. Rinsing does not empty the wash head completely. Follow the rinse with a Purge step before you remove the wash head or shutdown the system.

Standby Settings

Use Standby mode to keep wash fluid in the head without the need to prime the head if there is a delay between uses.

The Standby step fills the prime/soak trough with a wash fluid and leaves the dispense/aspirate probes in the wash fluid.

You can use the touch screen buttons to select the source bottle for the wash fluid and to program the wash fluid to automatically change at specific time intervals.

To discontinue the Standby step and continue using the AquaMax Microplate Washer, touch Cancel. This drains the trough and dispenses a small amount of the wash fluid through the dispense needles.

Table 4-19: Standby settings

Item	Description
1	Inlet–Liquid to be used for this step. The available options correspond to the color-coded reagents connected to the washer.
2	Prompt–Indicates that the system will pause before dispensing and wait for the user to specify an inlet.
3	Change solution every–Drains and refills the solution in the soaking trough at the specified refresh interval.

Prime Settings

The Prime step primes the internal fluidics and installed wash head with the selected reagent. During the Prime step, the needles are immersed in the priming liquid to wash the outsides of the needles. This is a maintenance step and does not require a microplate to run.

Table 4-20: Prime settings

Item	Description
1	Inlet–Liquid to be used for this step. The available options correspond to the color-coded reagents connected to the washer.
2	Prompt–Indicates that the system will pause before dispensing and wait for the user to specify an inlet.
3	Mode–Level of priming fluid. • Maintenance: Uses 150 mL of the reagent to prepare the instrument after long periods of system inactivity. • Full: Uses 400 mL of the reagent to prepare the instrument after a wash head installation, reagent exchange, or system purge.

Managing the Program Library

All programs can be modified. Factory-provided one-touch programs can be edited, but not renamed or deleted.

Note: Program options and menus are optimized for the installed wash head. Before creating or editing a program, make sure that the appropriate wash head is installed. Do not remove the wash head until your program changes have been saved. Removing the wash head resets the touch screen. Any unsaved program changes are lost.

To create a new program

1. On the **Program** tab, touch **New**.

Figure 4-4: Program tab

Tip: You can also create a new program by copying an existing program (see To copy a program on page 64).

2. Type a name for the new program on the keypad, and touch **OK**.

   The Program Settings dialog opens automatically.

3. In the **Program Settings** dialog, touch a plate type from the **Plate** list.

Figure 4-5: Program settings

Note: Plates that are not compatible with the installed wash head appear gray.

4. If applicable, click **Program Options** to add Program Start and Program Done messages to the program (see), enable stacker options for the program (see), or adjust the dispense rate accuracy for the program.

Figure 4-6: Program options

> **Note:** Test dispense accuracy separately and use the results to adjust the settings in your program. For more information, see To adjust dispense accuracy for a program on page 68.

5. Touch **OK** to save your changes and close the Program Settings dialog.
6. Add steps to the program. For more information see To add a step to a program on page 65.
7. Touch **Done** to exit programming mode.
8. Touch **Yes** to confirm your changes.

To copy a program

1. On the **Program** tab, touch the program to be copied, and touch **Copy**.
2. In the **Copy Program** dialog type the name of the new program. The default name of the copy is the name of the existing program followed by an asterisk (*).
3. In the **Program Settings** dialog, select a plate type and touch **OK**.
4. Edit the steps in the program as required:
   - Add a step
   - Copy a step
   - Edit a step
   - Delete a step
5. Touch **Move Up** and **Move Down** to rearrange program steps within the list.
6. Touch **Done** to exit programming mode.
7. Touch **Yes** to confirm your changes.

To edit a program

1. Select the program to be edited, and touch **Edit**.
2. Touch **New** to add new steps, or touch **Edit**, **Copy**, or **Delete** to modify existing ones.
3. Touch **Move Up** and **Move Down** to rearrange program steps within the list.
4. After all program steps have been set up, touch **Test** to execute a test run, or touch **Done** to exit programming mode.
5. Touch **Yes** to confirm your changes.

To rename a program

1. Select the program to be renamed, and touch **Rename**.
2. Type a new name for the program.
3. Touch **OK** to save the change.

Note: One-touch programs cannot be renamed.

To delete a program

Note: A deleted program cannot be recovered.

1. Select the program to be deleted, and touch **Delete**.
2. Touch **OK** to confirm the deletion.

Note: One-touch programs cannot be deleted.

To change the plate type for a program

1. Select the program to be edited, and touch **Edit**.
2. In the program details area, touch **Program Settings** and touch **Edit**.
3. Select the plate type.
4. Touch **OK** to exit the **Program Settings** dialog.
5. Touch **Done** to exit programming mode and **OK** to confirm your changes.

To add a step to a program

1. Select the program to be edited and touch **Edit**. The Program tab displays the details for the selected program.

Figure 4-7: Program tab, program editing

2. To add a step, touch **New** and touch the type of step you want to add. The parameters dialog for the selected step type appears.

3. Complete the parameters dialog and touch **OK** when finished. The newly-created program step appears in the program list.

> **Note:** For information about step types and associated parameters, see New Step Selection on page 46.

4. For each additional program step, repeat Step 2 and Step 3

5. Touch **Move Up** and **Move Down** to rearrange program steps within the list.

6. To test run the program, touch **Test**.

7. Touch **Done** to exit programming mode.

8. Touch **Yes** to confirm your changes.

To edit a step in a program

1. Select the program to be edited and touch **Edit**.

   The Program tab displays the details for the selected program.

2. Select the step you want to work with and choose one of the following options:

   ♦ To edit the selected step, touch **Edit** and change the parameters in the associated dialog as required. Touch **OK** to close the dialog.

   ♦ To copy the selected step, touch **Copy**. The copied step is added to the end of the program.

   ♦ To delete the selected step, touch **Delete**.

   Note: For information about step types and associated parameters, see New Step Selection on page 46.

3. Touch **Move Up** and **Move Down** to rearrange program steps within the list.

4. To test run the program, touch **Test**.

5. Touch **Done** to exit programming mode.

6. Touch **Yes** to confirm your changes.

To adjust dispense accuracy for a program

Dispense accuracy in the AquaMax Microplate Washer is set to specification during manufacturing. However, various installation configurations can also affect accuracy, such as location and size of reagent bottles, types of reagent, and so on. These adjustment are specific and individual to every program. However, after you determine an adjustment for a given set of parameters, you can use the same setting whenever that combination is used (Liquid type, Head type, and so on).

The AquaMax Microplate Washer supports 4 L or 10 L bottles only.

For best results test dispense accuracy in a separate program and use the results to adjust your working program.

1. Make sure that the system is set up to match the parameters of your working program.

2. Create a new program and in the **Program Settings** dialog, touch **Program Options**.

3. Touch **Adjust Dispense**.
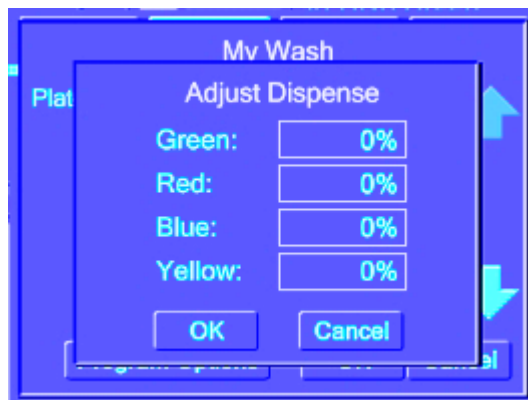
Figure 4-8: Adjust dispense options

4. In the **Adjust Dispense** dialog, set the adjustment to 0% for the chosen fluid inlet.

5. Weigh an empty plate.

6. Complete the program with a dispense function from the fluid inlet of choice: 300 µL/well/96-well plate or 100 µL/well/384-well plate.

7. Run the program.

8. Weigh the plate after the dispense to measure the amount of liquid dispensed.

9. Divide the fluid mass by the fluid density and number of wells to get the measured volume per well:

$$Measured\ volume\ per\ well\ =\ \frac{Fluid\ mass\ \S\ Fluid\ density}{Number\ of\ wells\ (96\ or\ 384)}$$

10. Determine the fractional dispense accuracy using the equation below:

$$Dispense\ accuracy\ =\ 100 \times \left(\frac{Measured\ Volume}{Expected\ Volume}\right) - 100$$

11. Round up this value to the nearest integer and type it in the **Adjust Dispense** dialog for the chosen fluid inlet. Use whole numbers in the range of 50% to 200%.

12. Repeat Step 3 to Step 11 for each fluid intake that needs adjusting.

13. Enter the results in the **Adjust Dispense** dialog of your working program.

Plates Tab

The Plates tab contains the functions for managing the plate library.
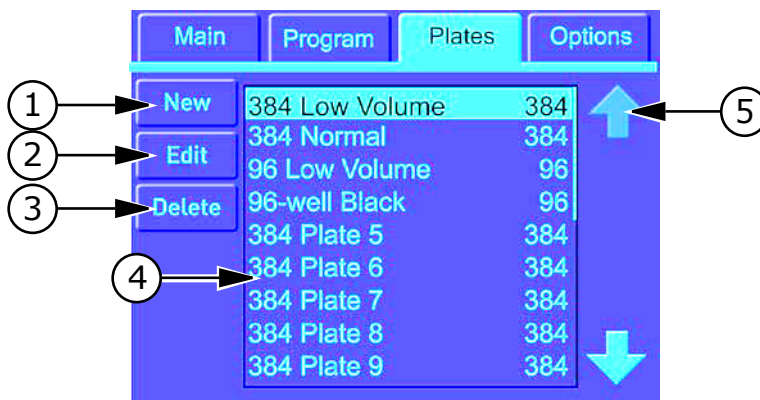
Table 4-21: Plates tab

Item	Description
1	New–Creates a new plate type.
2	Edit–Opens the details of the selected plate type for editing.
3	Delete–Deletes the selected plate type.
4	Plate List–Lists the plate types stored in the library.
5	Up Arrow and Down Arrow–Moves up and down through the plate list if the list exceeds the display area.

Plates Tab: Administrative Mode

In administrative mode, general users have access to only the View button and the Admin button. The Admin button and the administrator passcode access the plate editing options.
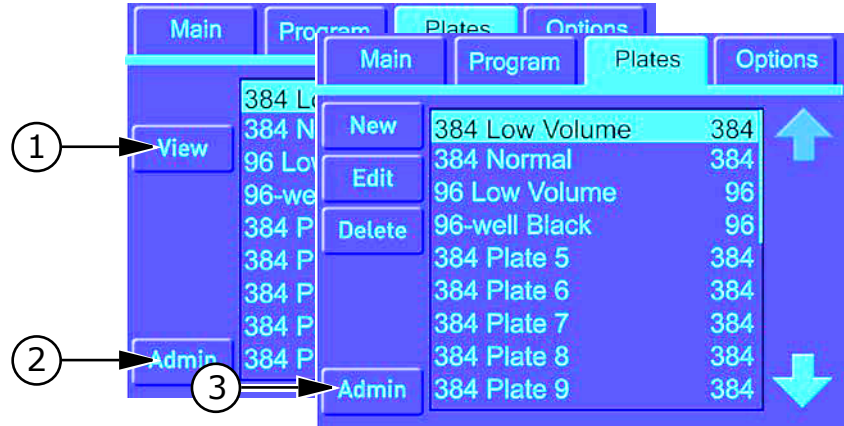
Table 4-22: Plates tab with administrative mode

Item	Description
1	View–Opens the selected plate so that you can view the plate details.
2	Admin–Opens the passcode dialog to access the plate editing options.
3	Admin–Indicates that the AquaMax® Microplate Washer is in administrator mode, and exits administrator mode when your changes are complete.

For information about the plate editing buttons, see Plates Tab on page 70.

For information about restricting access to editing functions, see Restricting Functions on page 80.

Plate Definition Dialog

A plate definition details the parameters used by the instrument during operations. The plate definition controls the position of the plate and the probes. Inaccurate settings can cause some operations to run incorrectly.
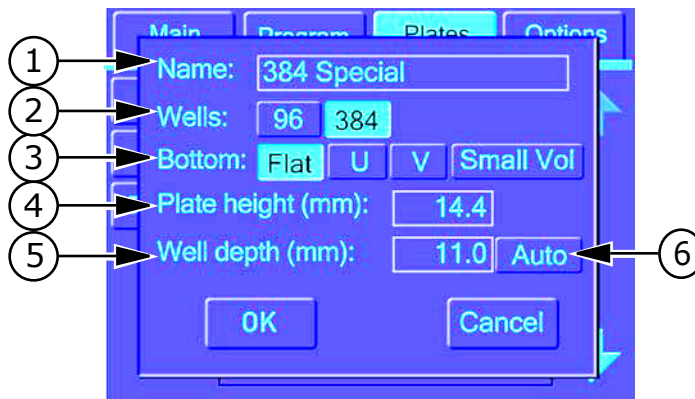
Table 4-23: Plate definition

Item	Description
1	Name–Name of the plate type. The name can be up to 20 characters.
2	Wells–Number of wells in the plate (96 or 384).
3	Bottom–Bottom profile of the wells: • Flat: plates with full-size flat-bottom wells. Crosswise and edge aspiration are supported for Flat plates only. • U: plates with round-bottom wells. • V: plates with tapered wells. • Small Vol: Small volume or half-area plates.
4	Plate Height (mm)–Distance in millimeters from the plate base to the top of the wells. When using a magnetic bead-washing insert (LifeSep 96F or 384F biomagnetic separators), the plate height is the total height of the carriage insert and plate stack. **Note:** Carriage inserts cannot be used with robotics.

Table 4-23: Plate definition (cont'd)

Item	Description
5	Well Depth (mm): Distance in millimeters from the bottom of the well to the top of the well. Well depth is critical to reliable instrument operation. An incorrect well depth can result in inefficient plate aspiration, plate and wash head damage, or "Vertical Error 225" appearing on the screen.
6	Auto–Calibrates the well depth. See To calibrate the well depth on page 73.

Managing the Plate Library

To create a plate type

✳ Tip: Values in the plate type dialog are automatically set to the parameters of the highlighted plate type. When creating a new plate type, select a similar plate type to start.

1. On the **Plates** tab, touch **New**.
2. Type a name for the new plate type and touch **OK**.
3. Select the plate parameters in the dialog.
4. Touch **OK** to save and exit.

To calibrate the well depth

When setting up a plate type, the system can automatically calibrate the well depth.

✳ Tip: We highly recommend this automatic feature when using a new plate type with your instrument.

1. In the **Plate Type Definition** dialog, touch **Auto** next to the **Well Depth** field.
2. Insert a plate in the carriage, and touch **OK**.

   The measured well depth appears in the Well Depth field.

To edit a plate type

1. Select the plate to be edited in the **Plate** tab, and touch **Edit**.
2. Select new plate parameters in the dialog.
3. Touch **OK** to save and exit, or **Cancel** to exit without saving.

   All programs that refer to the edited plate type are listed in red in the program list to indicate changes in the plate definition.

To delete a plate

1. Select the plate to be deleted in the **Plate** tab, and touch **Delete**.
2. Confirm the deletion.

Note: A deleted plate type cannot be recovered.

Options Tab

The Options tab contains instrument options and administrative functions.
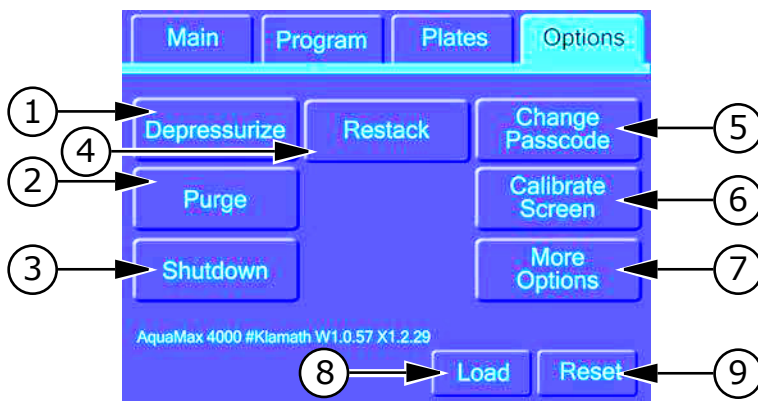
Table 4-24: Instrument options

Item	Definition
1	Depressurize–Releases the system and bottle pressure. During operation, the source bottles can be under mild pressure—up to 500 mmHg (10 psi or 70 kPa). Before changing the fluid in the source bottles, depressurize to avoid releasing pressure when opening the cap.
2	Purge–Purges the system fluidics. Purging empties the wash head, prime trough, and common fluid paths. Use this function before changing the wash heads to remove excess fluids. In addition, after a system failure, Purge can be used to drain the liquid left in the Prime/Soak trough.
3	Shutdown–Starts the user-defined automatic shutdown.
4	Restack–Commands the StakMax® stacker to move all plates currently in the output stack to the input stack, leaving them in their original input order. Restack is available only if a stacker is connected to the instrument.
5	Change Passcode–Opens the keypad where you can change the administrative passcode for the instrument. See Restricting Functions on page 80.
6	Calibrate Screen–Opens the Calibrate Screen where you can calibrate the touch positions on the touch screen. See Screen Calibration on page 81.
7	More Options–Opens the Advanced Options dialog.
8	Load/Eject–Loads or ejects the plate carriage. Use this option to retrieve a microplate after a system failure.
9	Reset–Performs a software reset without power cycling the instrument and positions the plate carriage at eject position.

Advanced Options Dialog
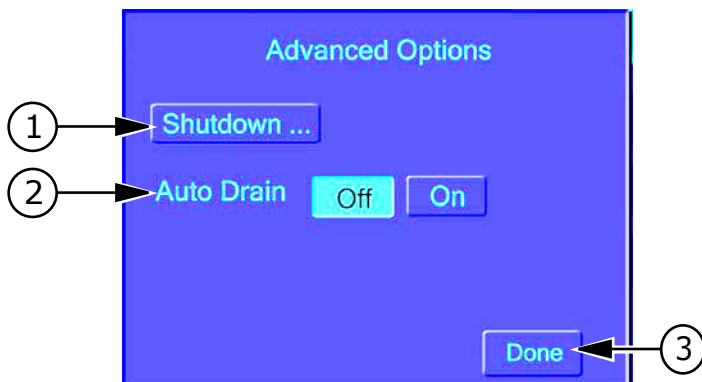
Table 4-25: Advanced options

Item	Description
1	Shutdown Options–Opens the Shutdown Options dialog where you can modify the instrument's automatic shutdown options. See Shutdown Options Dialog on page 78.
2	Auto Drain–Drains the trough every time the plate is ejected.
3	Done–Closes the Advanced Options dialog.

Options Tab: Administrative Mode

In administrative mode, general users have access to the following options:
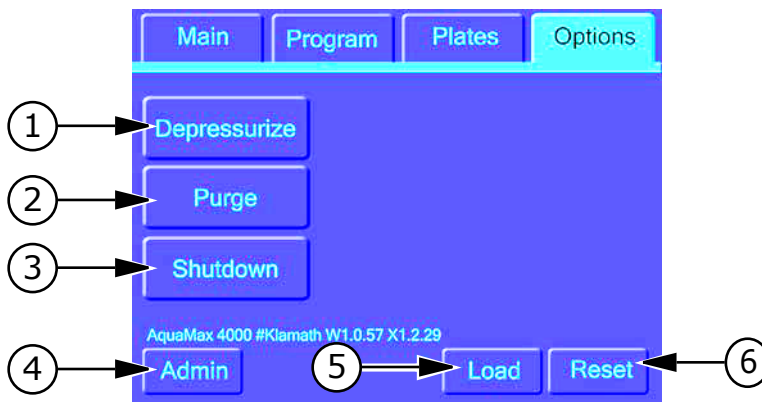
Table 4-26: Options tab with administrative mode

Item	Description
1	Depressurize–Releases the system and bottle pressure. During operation, the source bottles can be under mild pressure—up to 500 mmHg (10 psi or 70 kPa). Before changing the fluid in the source bottles, depressurize to avoid releasing pressure when opening the cap.
2	Purge–Purges the system fluidics. The wash head, prime trough, and common fluid paths are evacuated. Use this function before changing wash heads to remove excess fluids. In addition, after a system failure, Purge can be used to drain the liquid left in the Prime/Soak trough.
3	Shutdown–Starts the user-defined automatic shutdown.
4	Admin–Starts and exits administrative mode and provides access to secured functions. Administrative mode requires the administrative passcode.
5	Load/Eject–Loads or ejects the plate carriage. Use this option to retrieve a microplate after a system failure.
6	Reset–Performs a software reset without power cycling the instrument.

Shutdown Options Dialog
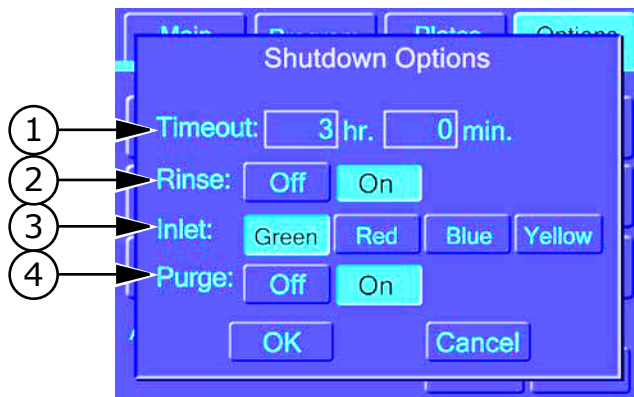
Table 4-27: Shutdown options

Item	Description
1	Timeout–Wait time in hours and minutes before the system enters Shutdown mode.
2	Rinse–Indicates whether the system should be rinsed before shutting down (On or Off).
3	Inlet–Liquid Input to be used for rinse fluid (Green, Red, Blue, or Yellow).
4	Purge–Indicates whether the system should be purged after rinsing and before shutting down (On or Off).

Managing the Software

Automatic Shutdown

The shutdown runs automatically when the instrument has been inactive for a user-specified amount of time. While the system is in shutdown mode, its power consumption is minimal.

Note: You can trigger the shutdown manually by touching Shutdown on the Options tab. To wake up the system, touch anywhere on the screen.

To set up the automatic shutdown

Long periods of inactivity can increase the chance of clogging due to solutions settling in the fluid channels and wash heads.

1. On the **Options** tab, touch **Other Options**.
2. Touch **Shutdown Options**.

   The Shutdown Options dialog appears.
3. Adjust the settings as required.

Note: Touch the hr. and min. boxes to access the keypad.

4. Touch **OK** to save your changes and exit.

Restricting Functions

By default, no passcode is set, and all functions are available to all users.

The AquaMax Microplate Washer can be set up to use an Administrative passcode to prevent unintentional modifications to stored programs, plate types, and instrument settings. Setting an administrative passcode restricts access to the following program editing functions and options:

- New (Program, Plates)
- Rename (Program)
- Delete (Program, Plates)
- Calibrate screen (Options)
- Edit (Program, Plates)
- Copy (Program)
- Restack (Options)
- Change passcode (Options)
- Shutdown options (Options)

You can access the restricted functions by touching the Admin button and entering the administrative passcode. The passcode must be entered for each tab separately.

To set or change the passcode

Note: If the Change Passcode button is unavailable, a passcode has been set previously.

1. Touch **Admin** and type in the current passcode to enter Administrative mode.
2. Touch **Change Passcode** in the **Options** tab.
3. Type a new passcode using the on-screen keypad.
4. Touch **OK** to save and exit.

To remove the administrative passcode

1. Touch **Admin** and type in the current passcode to enter Administrative mode.
2. Touch **Change Passcode** in the **Options** tab.
3. Delete the existing passcode using the back arrow key.
4. Touch **OK** to save and exit.

Screen Calibration

The AquaMax Microplate Washer has a screen calibration feature that enables the user to calibrate the position of the touch screen overlay on the LCD screen.

To calibrate the screen

1. On the **Options** Tab, touch **Calibrate Screen**.
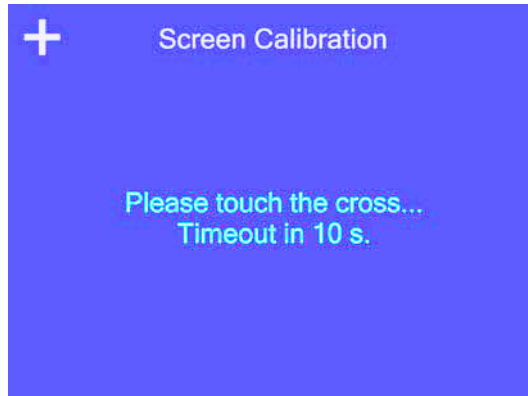
Figure 4-9: Screen calibration screen

2. Touch the crosses as they appear on the screen.

   The system exits Screen Calibration mode automatically when the calibration is completed, or when the 10-second timeout is reached.

Maintenance

<div style="text-align: right">**5**</div>

The following sections contain information about the maintenance of the AquaMax® series Microplate Washers.

All maintenance procedures described in this manual can be safely performed by experienced lab personnel. Review the manual prior to beginning the maintenance procedures. Maintenance not covered in this manual should be performed only by a Molecular Devices representative.

Technical Support

Molecular Devices is a leading worldwide manufacturer and distributor of analytical instrumentation. We are committed to the quality of our products and to fully supporting our customers with the highest possible level of technical service.

If you have any problems using your AquaMax Microplate Washer in the U.S., contact our Technical Support group at 1-800-635-5577. Elsewhere contact your local representative.

WARNING! BioHazard. Decontaminate the instrument and all accessories before requesting service by Molecular Devices representatives and before returning the instrument or any components to Molecular Devices.

WARNING! Risk of electrical shock. There are no user-serviceable parts in the interior of the instrument. Removal of protective covers that are marked with the High Voltage warning symbol can result in a personal injury. Refer servicing to Molecular Devices service representatives.

WARNING! Risk of electrical shock. Always turn the power switch off and disconnect the power cord from the main power source before performing any maintenance procedure that requires removal of any panel or cover or disassembly of any interior instrument component. Refer servicing to Molecular Devices service representatives.

WARNING! Never perform any operation on the instrument in an environment where potentially damaging liquids or gases are present.

CAUTION! Do not touch or loosen any screws or parts other than those specifically designated in the instructions. Doing so can cause misalignment and possibly void the warranty.

Routine Maintenance

Routine maintenance should be performed at the end of each day, or before extended inactivity on the instrument.

Routine maintenance includes the following activities:

- Purging the Instrument on page 85
- Decontaminating the Instrument on page 86
- Cleaning the Exterior on page 87
- Removing and Storing Wash Heads on page 88
- Cleaning Wash Heads on page 91

Purging the Instrument

CAUTION! All maintenance programs must be run with a wash head installed.

CAUTION! If using decontaminant solutions other than AquaMax Sterilant, consult the chemical compatibility table (Table B-1 on page 113) to verify that the decontaminant solution will not cause damage to the instrument.

Follow the procedures below to clean the microplate washer. Each step can be performed using one of the one-touch maintenance programs or a similar user-defined program.

To purge the instrument

1. Prime each inlet used with sterile water to remove the last wash buffers used.

2. Clean each inlet with a cleaning solution using the one-touch **Clean** program.

   The one-touch Clean program cleans and decontaminates internal fluid paths. The system primes with the cleaning solution, pauses for 5 minutes to allow the cleaning solution to soak in the system, and follows with 3 rinse cycles using the rinse solution. The default program uses the red inlet for cleaning and the green inlet for rinsing. The system is purged at the end of this program.

3. Purge all fluid from the system.

4. For long-term storage, Prime each inlet with an empty bottle to remove all fluids from the system.

Note: Reservoir bottles can be autoclaved without the caps. The caps cannot be autoclaved.

Decontaminating the Instrument

WARNING! Biohazardous Material. Wear protective equipment and dispose of waste materials in accordance with laboratory site regulations and procedures. Solutions used in the instrument and waste materials might be biohazardous.

WARNING! Chemical Waste Disposal Hazard. Wear protective equipment and dispose of waste materials in accordance with applicable regulations and procedures. Waste material might contain toxic, corrosive, and biohazardous material.

Decontaminate the instrument after using infectious or toxic materials in the instrument. You can safely use alcohol (such as ethanol or isopropanol) in the fluid channels and on the external surface of the instrument. You can also use AquaMax Sterilant or other commercially-available laboratory decontaminants. See Table B-1: AquaMax® Microplate Washer Compatible and Incompatible Cleaning Solutions on page 113 for a list of compatible and incompatible cleaning solutions. These products remove buildup of blood serum, fatty and amino acids, protein complexes, and polymer films to prevent clogging of the washer channels and wash heads. Such solutions should be mixed according to the manufacturers' instructions.

Note: The interaction between disinfectants and the materials used in the AquaMax Microplate Washer should be carefully considered before disinfectants are introduced.

Cleaning the Exterior

WARNING! Biohazardous Material. Wear protective equipment and dispose of waste materials in accordance with laboratory site regulations and procedures. Solutions used in the instrument and waste materials might be biohazardous.

WARNING! Chemical Waste Disposal Hazard. Wear protective equipment and dispose of waste materials in accordance with applicable regulations and procedures. Waste material might contain toxic, corrosive, and biohazardous material.

WARNING! Risk of electrical shock. There are no user-serviceable parts inside the instrument. Refer servicing to Molecular Devices service representatives.

CAUTION! Risk of equipment damage. Do not open the panels and covers to clean inside the instrument. The exposed circuitry and power supply inside the instrument can be damaged by water-based or conductive cleaning agents. Refer servicing to Molecular Devices service representatives.

Periodically, you should clean the outside surfaces of the instrument using a cloth or sponge that has been dampened with water.

- Do not use abrasive cleaners.
- If necessary, use a mild soap solution diluted with water or a glass cleaner, and wipe clean with a damp cloth or sponge to remove any residues.
- Do not spray cleaner directly onto the instrument.
- If needed, clean the microplate drawer using a cloth or sponge that has been dampened with water.

Fluids that spill in the instrument during operation drain through the prime/soak trough.

CAUTION! If the trough fluid overfills or spills elsewhere, it leaks through the bottom of the instrument to the counter beneath and must be wiped up immediately to prevent damage.

Removing and Storing Wash Heads

Heads must always be washed and purged before they are removed. Any remaining fluid can spill out onto the instrument and potentially cause damage. Fluid remaining in the head can also lead to the growth of mold and salt crystals, causing blockage in the dispense and aspiration probes.

WARNING! Biohazardous Material. Wear protective equipment and dispose of waste materials in accordance with laboratory site regulations and procedures. Solutions used in the instrument and waste materials might be biohazardous.

WARNING! Chemical Waste Disposal Hazard. Wear protective equipment and dispose of waste materials in accordance with applicable regulations and procedures. Waste material might contain toxic, corrosive, and biohazardous material.

To remove the wash head

1. To prepare the wash head for removal, run the one-touch **Rinse** program using sterile water as the rinse fluid. (See Program Tab on page 38.).

   Note: Repeat several times if a particularly harsh reagent was used previously.

2. On the **Options** tab, touch **Purge** to remove water from the head.
3. Disengage the lever mechanism and remove the wash head.
4. Always store wash heads with the clear plastic guards installed, with the probes facing down, and on a flat surface or inside a protective container.

   Note: For long-term storage, use the clamshell container from the original shipment.

   Tip: If the carriage does not eject automatically after an error condition or power outage, retrieve the carriage manually by following instructions in To recover the microplate and wash head manually on page 90.

To recover the microplate and wash head manually

The Reset button on the bottom right corner of the Options tab performs a software reset without power cycling the instrument. If the washer fails during an operation, perform a reset to manually retrieve any microplate still stuck in the system.

1. To return the wash head and microplate to their unloaded positions, touch **Reset**.

2. Retrieve the microplate.

   If the plate carriage cannot be unloaded by a software Reset, continue with the following steps.

3. Lift the wash head gently by the finger guard until it clears the microplate.

CAUTION! Do not touch or put pressure on the dispense or aspiration probes, as they can be damaged easily.

4. Disengage the lever mechanism and remove the wash head.

5. Carefully slide the plate carriage out.

6. If the plate carriage is stuck, touch **Load/Eject** in the **Options** tab.

7. Remove the plate from the plate carriage.

Cleaning Wash Heads

Occasionally one or more of the aspiration/dispense probes might be clogged if the wash heads are not purged properly after use. When one or more probes are clogged, you might see uneven dispense/aspirate rates, or liquid dripping out of the probes.

To clean wash heads using the on-board programs

1. On the **Main** tab, touch **Clean** to clean the wash head with the AquaMax Sterilant.

   The one-touch Clean program cleans and decontaminates internal fluid paths. The system primes with the cleaning solution, pauses for 5 minutes to allow the cleaning solution to soak in the system, and follows with 3 rinse cycles using the rinse solution. The system is purged at the end of this program.

   The standard setup has the AquaMax Sterilant connected to the red inlet and the rinse water connected to the green inlet.

   If desired, you can change the parameters of the one-touch Clean program. See Program Tab on page 38.

   Note: If the problem persists, clean the wash head in an ultrasonic wash bath with either sterile water or a mild detergent. If necessary, clean individual clogged dispense or aspiration probes with cleaning wires.

   Note: To clean a wash head for storage, follow the cleaning procedure in To prepare the wash head for storage on page 94.

Moving an AquaMax® Microplate Washer

Make sure that the new location meets the specifications as described in Setting Up the Instrument on page 21.

To move an AquaMax® Microplate Washer to another location

1. Remove any microplate from the instrument.
2. For extended storage, follow the procedures in Purging the Instrument on page 85 to remove all reagents from the system. If the instrument will be used immediately after the move, a **Purge** cycle is sufficient.
3. Remove any installed wash head.
4. Disconnect all source and waste bottles and tubing.
5. Turn off the power switch and unplug the power cord.
6. Tilt the microplate washer to drain any liquid that might have spilled during microplate washer operation.
7. Empty the waste reservoir.

Note: Depending on the distance that you are moving the instrument, you might want to repackage it in its original shipping packaging to secure the Z and Y axis motion stages.

If you do not have the shipping container for the AquaMax Microplate Washer, please contact Technical Support to obtain a replacement container.

Preparing for Storage

To turn off the instrument

Use this procedure for prolonged inactivity. For regular use, the automatic shutdown feature manages power, screen, motors, and valves. (See Automatic Shutdown on page 79.)

1. Make sure that the wash head remains installed throughout the procedure.
2. Make sure that the waste tubing is correctly installed with either a waste bottle or drain. See To connect a waste bottle on page 24.
3. On the **Main** tab, touch **Rinse**. Use AquaMax Sterilant, DI water, or your usual rinsing agent.
4. On the **Options** tab, touch **Purge**.
5. Make sure that the **Prime** program specifies **Prompt for the Inlet** option. See To edit a program on page 64.
6. Replace each reagent bottle with an empty bottle. See To connect a reagent bottle on page 21.
7. On the **Main** tab, touch **Prime** and specify the inlet with the empty bottle. Repeat this step two more times.

Note: If you do not have enough empty bottles, you can perform Step 6 and Step 7 separately for each inlet in turn.

8. When the fluid channels have been cleaned and emptied, remove the wash head before turning off the power. See To prepare the wash head for storage on page 94.
9. On the back of the instrument, switch the power switch to the **Off** position.

To prepare the wash head for storage

Note: If you have followed the instructions in To turn off the instrument on page 93, then skip Step 1 and Step 2 of this procedure and start at Step 3.

1. On the **Main** tab, touch **Rinse**. Use AquaMax Sterilant, DI water, or your usual rinsing agent.
2. On the **Options** tab, touch **Purge**. The wash head can retain approximately 3 cc of liquid after a purge.
3. Release the locking lever on the wash head and lift the wash head away from the instrument.
4. Turn the wash head so that the inlets for the wash head are pointing down over a folded paper towel. Avoid touching the probes.
5. Drain any remaining fluid from the wash head by gently tapping the inlet end on the paper towel.

Tip: To achieve the greatest level of dryness, you can do a second rinse with ethanol through each of the four inlets on the wash head to help dry the wash head and the system. Follow Step 1 through Step 5, substituting ethanol as the rinse agent.

6. Store the wash head in the provided container.

Troubleshooting

This chapter lists errors that might occur while using the instrument, followed by their most likely causes and remedies.

Troubleshooting Charts

If you experience a problem during operation of the AquaMax® Microplate Washer, locate the problem in the following table and perform the recommended tasks. For problems not listed here, or if the listed resolution does not fix the problem, please call the Technical Support department at the number listed in Technical Support on page 83.

> **Note:** It is your responsibility to decontaminate the instrument, as well as any accessories, before requesting service by Molecular Devices representatives and before returning the instrument or any components to Molecular Devices.

General Instrument Issues

Table 6-1: General Instrument Issues

Problem	Possible Causes & Remedies
No power to the instrument or touch screen.	The instrument might have gone into Shutdown mode: • Touch anywhere on the screen to activate it.
	No power to the instrument: • Check that the power cord is plugged in. • Check that the power outlet has power. • Verify the power switch is turned to the ON position.
The plate carriage or wash head does not move freely.	Obstruction to the motion of the wash head or plate carriage: • Remove any obstructions from the path of the wash head or plate carriage.

System Fluidics Issues

Table 6-2: System Fluidics Issues

Problem	Possible Causes & Remedies
Air in the bottle lines.	Prime lines using the one-touch Prime program.
Leaks from the liquid inlet quick connects on the left side of the washer.	When the bottle tubing is disconnected from the quick-connect, it is normal for a small amount of liquid to leak from the inlets.
The prime trough does not drain and is filled with liquid.	Manually purge the trough by touching Purge in the Options tab. This will also empty the wash head.
Liquid under instrument.	If the overflow drain (see Figure 6-1) is full or wet, and liquid is overflowing from the prime/soak trough: • Verify that the total dispense volume in the program does not exceed the maximum well volume for the plate in use. • Adjust the dispense accuracy, see To adjust dispense accuracy for a program on page 68. • Remove any blockage in the prime/soak trough.
	If the overflow drain is completely dry: • Check around the instrument for other sources of leaks, such as the tubing connectors from the bottles. • If the leakage is coming from within the instrument, contact Technical Support. **Note:** A small amount of liquid will not cause damage to the instrument. If the trough is full, manually purge the trough by touching Purge in the Options tab. Carefully wipe up any spills under the instrument.

System Pressure Issues

Table 6-3: System Pressure Issues

Problem	Possible Causes & Remedies
Pressure timeout error 154.	If the system cannot achieve target bottle pressure: • Check that all pressure fittings are properly connected. • Tighten caps on all reservoir bottles. • Remove all pressure tubing from the bottles, and reconnect them to one reservoir bottle at a time, to determine which bottle is having pressure problems. • Inspect the air tubing for leaks. • Disconnect the air and liquid connectors from washer, but leave the waste connected, and then run the program. If the problem is bottle-specific or hose-specific, you should not get the error. If the error persists, then contact Technical Support. **Note:** If the total air volume in all the bottles is large (>10 L), it can take up to 5 minutes to pressurize the bottles.
Loud pump noise during operation.	Waste tubing might have been connected incorrectly: • Verify that the waste tubing has no shut-off valve on either end. • Verify that the waste tubing is connected to the Waste Output on the left side of the instrument. • Verify that the free end of the waste tubing is in a sink drain or a vented bottle below the height of the instrument.

External Communication Issues

Table 6-4: External Communication Issues

Problem	Possible Causes & Remedies
The StakMax® stacker is not communicating.	Verify that the StakMax cable is connected to both the StakMax stacker and the AquaMax® Microplate Washer.
	Power-cycle both instruments to re-establish the connections.
The robot is not communicating.	Verify that the USB cable is connected to both the robot and the AquaMax Microplate Washer.
	Verify that the communication port setting corresponds to the virtual COM port assigned to the USB driver.
	Power-cycle both the robot and the AquaMax Microplate Washer to re-establish connections.
Data cannot be downloaded from instrument to computer using the AquaMax Utility.	Verify that the USB cable is plugged into both the AquaMax Microplate Washer and the computer.
	Verify that the communication port setting corresponds to the virtual COM port assigned to the USB driver.
	Restart the computer and power-cycle the AquaMax Microplate Washer to re-establish connections.

Dispense Issues

Table 6-5: Dispense Issues

Problem	Possible Causes & Remedies
No liquid in the plate after dispense.	Verify that the dispense parameters (inlet, volume) are set correctly.
	Verify that all appropriate bottles and tubing are connected to the instrument, and that the bottles are not empty.
	Verify that the system has been primed properly.
Dispense precision is out of spec (high CV, left-right bias, empty wells, or outliers).	Air bubbles in the wash head or system fluidics: • Run a full Prime, such as the One-touch Prime program.
	One or more dispense probes might be clogged: • Follow the procedures in Cleaning Wash Heads on page 91 to unclog the probes.
Dispense accuracy is out of spec (high/low dispense volume).	Dispense adjustment values might be incorrect: • Adjust the dispense accuracy, see To adjust dispense accuracy for a program on page 68.
Dripping from the dispense probes.	Air bubbles in the wash head or system fluidics: • Run a thorough prime program (such as the one-touch Prime program).
	One or more dispense probes might be clogged: • Follow the procedures in Cleaning Wash Heads on page 91 to unclog the probes.
Dispense overfills the plate.	Dispense volume might be set too high: • Verify that the total dispense volume in the program does not exceed the maximum well volume for the plate in use.
	Dispense adjustment values might be incorrect: • Adjust the dispense accuracy, see To adjust dispense accuracy for a program on page 68.

Aspiration Issues

Table 6-6: Aspiration Issues

Problem	Possible Causes & Remedies
The microplate is stuck on the wash head after aspiration or wash.	Microplates with conical or tapered bottoms (such as certain V-bottom or small-volume/half-area plates) might be incompatible with aspiration and wash operations.
Incomplete aspiration across the entire plate.	Incorrect plate definition: • Verify that all plate parameters in the plate library match the plate in use. If necessary, re-calibrate the well depth using the Auto feature according to Plate Definition Dialog on page 72.
	Incorrect aspiration parameters: • 96-well plates require crosswise aspiration to achieve minimal residual volumes. If necessary, change the aspirate mode to CrossWise. • Aspirate dwell time and rate might have to be increased. See Aspirate Settings on page 49. • Aspirate probe height should be set at 0.0 mm to 0.2 mm for minimal residual volumes. See Aspirate Settings on page 49.
	Note: If aspiration problems persist, follow the Aspirate Testing Procedure that is part of the instrument's Performance Qualification. If you do not have this procedure, please contact Technical Support.

Table 6-6: Aspiration Issues (cont'd)

Problem	Possible Causes & Remedies
Significant residual liquids in a few wells.	One or more aspiration probes might be clogged: • Follow the procedures in Cleaning Wash Heads on page 91 to unclog the probes.
	Aspiration probe tips might be touching the well bottoms: • Verify that all plate parameters in the plate library match the plate in use. If necessary, re-calibrate the well depth using the Auto feature according to Plate Definition Dialog on page 72. • Increase the aspiration probe height.
	Note: All wells should have approximately an equal volume of liquid prior to the aspiration step. Uneven initial well volumes can cause incomplete aspiration.
Dripping from the aspiration probes.	Residual fluids in the aspiration probes: • Increase the aspiration Dwell time. • Select Fast descent speed and increase aspiration rate.
	One or more aspiration probes might be clogged: • Follow the procedures in Cleaning Wash Heads on page 91 to unclog the probes.

Wash Issues

Table 6-7: Wash Issues

Problem	Possible Causes & Remedies
Some wells overflow during wash.	Aspiration probe tips might be touching the well bottoms during bottom wash: • Verify that all plate parameters in the plate library match the plate in use. If necessary, re-calibrate the well depth using the Auto feature according to Plate Definition Dialog on page 72.
	Wash solution surface tension causing uneven aspiration: • Add surfactant (such as Tween) to the wash solution.
	Wash volume is too high: • Decrease the wash volume. The wash volume should not exceed 10x well volume.
	One or more aspiration/dispense probes might be clogged: • Follow the procedures in Cleaning Wash Heads on page 91 to unclog the probes.
Liquid left in wells after Wash program step.	By design, the Wash step leaves some residual liquids in the wells. Follow the Wash step with an Aspirate step to remove the liquids if desired.

Cell Wash Issues

Table 6-8: Cell Wash Issues

Problem	Possible Causes & Remedies
Coating or cells in wells are damaged after wash or aspirate.	Decrease the aspiration rate (96-cell wash head only).
	Decrease the aspiration dwell time
	Increase the aspiration probe height.
Coating or cells in wells are damaged after dispense.	Decrease the dispense rate.
	Note: For the 384-cell wash head, we recommend to use as high a dispense rate as possible without damaging the cell layer.

Instrument Error Messages

After performing the recommended tasks in Table 6-9, touch Stop or Cancel to continue.

WARNING! **Before manually checking for obstructions, turn off the power to the AquaMax Microplate Washer.**

Table 6-9: Instrument Error Messages

Problem	Possible Causes & Remedies
"Z-Motor Pinched" or "Z-Motor Stalled" Error.	Obstruction to the motion of the wash head: • Turn off the power to the washer and then remove any obstructions from the path of the wash head.
	Incorrect plate definition • Verify that plate height and well depth in the plate library match the plate in use. If necessary, re-calibrate the well depth using the Auto feature according to Plate Definition Dialog on page 72.
	Improper alignment between the wash head and plate carriage: • The dispense/aspiration probes should be aligned to the center of the wells. If they are not, please contact Technical Support.
"Y-Motor Pinch" Error.	Obstruction to the motion of the plate carriage: • Turn off the power to the washer and then remove any obstructions from the path of the plate carriage.
"Y: Failed find home" Error	Obstruction to the motion of the plate carriage: • Turn off the power to the washer and then remove any obstructions from the path of the plate carriage.
	The plate carriage home sensor might be malfunctioning: • Turn off the instrument and remove the wash head. • Slide the plate stage forward to reveal the plate carriage home sensor on the left side of the prime trough (see Figure 6-1). • Use a lint-free paper towel to dry the interior and the region around the sensor. • When the sensor is completely dry, turn on the instrument again.
	Note: If the error persists, the sensor might need to be replaced. Please contact Technical Support.

Table 6-9: Instrument Error Messages (cont'd)

Problem	Possible Causes & Remedies
"Z: Failed find home" Error 220	Obstruction to the motion of the wash head: • Turn off the power to the washer and then remove any obstructions from the path of the wash head.
	The wash head home sensor might be malfunctioning: • In the Options tab, touch Reset.
	Note: If the error persists, the sensor might need to be replaced. Please contact Technical Support.
"No Plate Detected" Error 178	No plate in the plate carriage: • Verify there are no obstructions in the plate carriage. • Place a plate in the plate carriage • Turn off the power to the washer and then move the carriage in and out and clean around the white carriage clip using an ethanol-dampened swab.
	Plate sensor is malfunctioning: • The sensor might be misaligned. Please contact Technical Support.
Pressure timeout error 154.	If the system cannot achieve target bottle pressure: • Check that all pressure fittings are properly connected. • Tighten caps on all reservoir bottles. • Remove all pressure tubing from the bottles, and reconnect them to one reservoir bottle at a time, to determine which bottle is having pressure problems. • Inspect the air tubing for leaks. • Disconnect the air and liquid connectors from washer, but leave the waste connected, and then run the program. If the problem is bottle-specific or hose-specific, you should not get the error. If the error persists, then contact Technical Support.
	Note: If the total air volume in all the bottles is large (>10 L), it can take up to 5 minutes to pressurize the bottles.

Figure 6-1: Plate stage home sensor
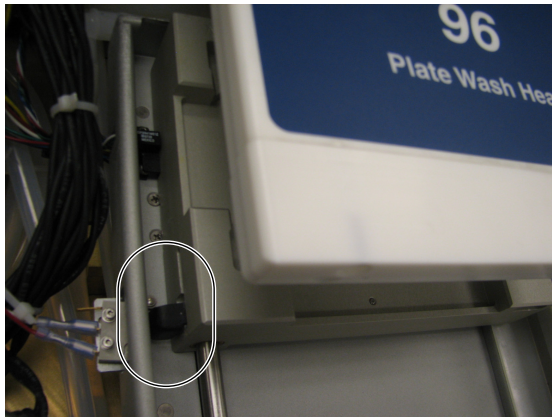
Figure 6-2: Plate sensor

Specifications

7

Technical specifications are subject to change without notice.

AquaMax® Microplate Washer

Table 7-1: AquaMax® Microplate Washer Specifications

Microplate Compatibility	
Microplates	96-well and 384-well with SBS footprint (128.2 mm × 86.0 mm) and height (13.5 to 15.5 mm)
	Note: Compatibility with 96-well strip plates varies across brands due to plate designs. In general, more rigid strip plate types are compatible, and more flexible strip plate types are not. See Supported Microplates on page 15.
Dispense Precision (plate-wash heads)	
96-well	4% CV @ 300 µL
384-well	4% CV @ 100 µL
Dispense Accuracy (plate-wash heads)	
96-well	3% @ 300 µL* * When calibrated with your wash solution using the dispense adjustments feature. See To adjust dispense accuracy for a program on page 68.
384-well	3% @ 100 µL
Washing Times	
96-well single cycle	11 seconds
96-well three cycles	6 seconds
384-well single cycle	12 seconds

Table 7-1: AquaMax® Microplate Washer Specifications (cont'd)

Microplate Compatibility	
384-well three cycles	28 seconds
FastWash Times (optimized for speed)	
96-well wash head, 300 µL per well, three cycles	14 seconds
384-well wash head, 100 µL per well, three cycles	16 seconds
Process time with integrated, optional StakMax® Microplate Handling System	
Fast Wash, 96-well wash head, 300 µL per well, three cycles	<13 minutes for 20 plates
Dispense Volume	
96-well	10 µL to 350 µL per well
384-well	5 µL to 150 µL per well
Wash Volume	
	100 µL to 3000 µL per well
Residual Volume (Plate Wash Heads Only)	
96-well	≤ 5 µL
384-well	≤ 2 µL
Robotics	
Robot compatible	Compatible with the StakMax® Microplate Handling System, and many third-party robotic microplate handling systems
Physical	
Size (H × W × D)	21 cm (8.3 in.) × 47 cm (18.5 in.) × 52 cm (20.5 in.)
Weight	18.5 kg (40.8 lbs)
Wash head	PET (polyethylene terephthalate), 304 stainless steel

Table 7-1: AquaMax® Microplate Washer Specifications (cont'd)

Microplate Compatibility	
Liquid-contact materials	Nylon, Polypropylene, Teflon, Polyethylene, Stainless Steel, Silicone
Electrical Power	Universal voltages: 100 V to 240 V~, 50 Hz to 60 Hz, 1.75 A

Microplate Library

Table A-1: Dimensions for Default Microplates in Plate Library

Name	# Wells	Bottom	Manufacturers' #	Height (mm)	Depth (mm)
Costar	96	Flat	3650, 3916, 3915, 3361, 3590, 9018, 3591, 9017, 3641, 3628, 3370, 2507, 2509, 2503, 3665, 3600, 3362, 3917, 3912	14.20	10.67
Falcon	96	Flat	353915, 353228, 353937, 353279, 353941, 353296	14.25	10.59
Greiner	96	Flat	655101	14.40	10.90
Nunc	96	Flat	165305	14.80	12.50
Costar	384	Flat	3640, 3652, 3654, 3662, 3680, 3700, 3701, 3702, 3703, 3704, 3705, 3708, 3709, 3710; 3723	14.20	11.43
Falcon	384	Flat	353234, 353239, 353962	14.32	11.50
Greiner	384	Flat	781091	14.40	11.50
Nunc	384	Flat	142761	14.40	11.70

Cleaning Solutions

Table B-1: AquaMax® Microplate Washer Compatible and Incompatible Cleaning Solutions

Compatible solutions	Incompatible solutions

• **AquaMax® Sterilant** * (see AquaMax Sterilant on page 115)
• 5% to 20% household bleach, or 0.25% to 1% sodium hypochlorite **
• 20% to 70% Ethanol
• CoulterClenz *
• Tergezyme *
• Pierce RBS 35 *
  * Follow manufacturer's directions for proper use.
  ** Do not leave bleach in the system for more that 15 minutes. Rinse thoroughly with water afterward to remove all bleach residue.
	• Strong Acids
	• Xylene, Toluene
	• NaOH, KOH, or other strong alkalines.
	• THF (Tetrahydrofuran)
	• Aldehydes
	• Esters
	• Aromatic Hydrocarbons
	• Halogenated Hydrocarbons
	• Ketones

Part Number: R8156

AquaMax® 2000/4000 Microplate Washer User Guide

AquaMax Sterilant

AquaMax® Sterilant (Part Number: R8156) can be used to clean and sterilize the fluid paths in the AquaMax Microplate Washer.

Principle of Use

Accumulated residues and contaminating microorganisms can impair the operation of liquid handling equipment. Proteins in cell culture media, salts and minerals in buffers, and other reagent components can build up on fluid path surfaces. This can clog channels and probes and can result in incomplete or inaccurate dispensing and aspiration. Microorganisms such as bacteria, fungi, and molds can accumulate in the fluid path creating similar fouling problems. Simply flushing the fluid path with water or ethanol/water solutions is often ineffective in removing residue.

AquaMax Sterilant was developed to remove organic and inorganic material and kill microorganisms, including endospores, in fluid paths in liquid handling instruments.

The AquaMax Sterilant simultaneously removes endotoxin from the fluid paths. Endotoxin is a substance produced by Gram negative bacteria that can cause a variety of significant cellular reactions in vitro, including cell activation and death. Minimizing the amount of endotoxin in fluid paths is necessary to avoid detachment and adverse effects on mammalian cells during the course of subsequent experiments. A two-hour treatment with the AquaMax Sterilant will substantially remove endotoxin adhering to interior fluid path surfaces.

Contents

- Sterilant Solution A Concentrate (4X): detergent in buffered aqueous solution (two 1 L bottles).
- Sterilant Solution B: sodium hypochlorite in aqueous solution (two 14 mL bottles)

Materials Required but Not Provided

- Deionized water
- Graduated cylinder, with minimum 500 mL capacity
- Pipettor, with minimum 1 mL capacity

Storage

Store the unopened kit package at a temperature between 10°C and 40°C.

After opening the kit:

- Store the Sterilant Solution A Concentrate (4X) and any 1X Solution A (prepared by mixing 1 volume of Sterilant Solution A Concentrate with 3 volumes of deionized water) at a temperature between 10°C and 40°C.
- Store the tightly capped bottle of Sterilant Solution B at a temperature between 2°C and 8°C.

Avoid freezing any of the solutions.

You must use the Complete Sterilant (prepared by mixing 0.2% of Sterilant Solution B with the prepared 1X Solution A) within one hour of preparation. Complete Sterilant cannot be stored for later use.

Preparing the Reagent

The automated cleaning cycle on the AquaMax Microplate Washer liquid handling system uses approximately 420 mL of Complete Sterilant. Molecular Devices recommend that you prepare 500 mL of Complete Sterilant to make sure that you have enough.

Preparing the Complete Sterilant

To prepare 500 mL of Complete Sterilant:

1. Combine 125 mL of Sterilant Solution A Concentrate (4X) and 375 mL of deionized water to prepare 1X Solution A.
2. Mix thoroughly.
3. Within 1 hour of use, add 1 mL of Sterilant Solution B to the 500 mL of 1X Solution A.
4. Mix thoroughly.

Note: You must use the Complete Sterilant within one hour of preparation. Complete Sterilant cannot be stored for later use. However, 1X Solution A can be prepared up to 30 days in advance.

Using Reagent

For stubborn cleaning situations, Molecular Devices recommends using the following procedure. You can modify the existing One-touch Cleaning program or create a new program.

1. Prime with Complete Sterilant (from the red inlet).
2. Soak for 5 minutes, or up to 2 hours for endotoxin removal.
3. Purge.
4. Prime with deionized water (from the green inlet).
5. Rinse with deionized water.
6. Repeat rinse twice, for a total of three rinses.
7. Purge.

Warnings, Precautions, and Limitations

For research use only.

When handling Solutions A and B, wear gloves and eye protection. Avoid ingestion. Use the solutions in a well-ventilated environment. For more safety information, consult the Material Safety Data Sheet for Solutions A and B.

As supplied, Solution A might not be sterile.

The following information is being provided in compliance with Worker and Community Right-To-Know Regulations:

Sterilant Solution A Concentrate (4X)

Chemical Composition

The chemical composition of this solution is a trade secret and proprietary property of Molecular Devices.

Sterilant Solution B

Chemical Composition: Sodium Hypochlorite, Solution
CAS #: 7681-52-9

Using the Washer for ELISA Based Applications

Objective: wash effectively to get a dry plate to achieve low background and improved signal.

All ELISA assays differ in their binding properties. Biochemical antigen-antibody interactions can be strong or weak.

In general, use:

- Medium to high dispense rate
- Medium to high aspiration rate
- Fast aspiration descent speed
- Long aspiration time
- Probe height set to 0 mm to 0.2 mm or bottom of the well
- Aspiration offset to the center of the well, or crosswise aspiration for a completely dry well
- Slow to fast plate shaking
- Bottom or Top washing

Using the Washer for Cell Based Applications

Objective: wash effectively without lifting cells off the well bottom to achieve a low background and improved signal.

All cells differ in their adherent properties. For example, CHO cells adhere strongly, while HEK293 cells tend to adhere weakly. In general, do not wash your cells any more than is necessary to achieve low background and sufficient signal.

Different cell lines will tolerate different wash conditions. The following are general recommendations, but each cell line and wash solution will require optimization by the user.

For best results with the 96 Cell Wash Head, use:
- Low dispense rate
- Medium to high aspiration rate
- Fast aspiration descent rate
- Short aspiration dwell time
- Probe height of 3 mm or more above the bottom of the well
- Gentle or no plate shaking

For best results with the 384 Cell Wash Head, use:
- High dispense rate
- High aspiration rate
- Fast aspiration descent rate
- Short aspiration dwell time
- Probe height of 2 mm or more above the bottom of the well
- Gentle or no plate shaking

Note: If a wash solution containing Tween or another reagent with low surface tension is used, and the primed head is allowed to sit between plate washes, some fluid loss through the dispense pins can occur. If this occurs, a maintenance prime is recommended before washing the next plate.

Robot Command Interface

Instrument Configurations

AquaMax® Microplate Washers can be externally controlled by a host computer. Using commands described here, the host computer can completely bypass the operation of the on-board touch screen.

A StakMax® Plate Stacker can be directly connected to an AquaMax Microplate Washer via a StakMax interface cable (Part Number: 0310-5454). External control is via commands described by this document sent to the washer only. Washer commands offer limited control of the stacker. There is no direct control of the StakMax Plate Stacker.

For complete control of both the AquaMax Microplate Washer and the StakMax Plate Stacker, or other robot, each device is connected separately to a host computer (via USB for the AquaMax Microplate Washer). The host computer must coordinate timing of actions of the washer and stacker robot.

Hardware Interfaces

Host Computer Interface

The host computer (PC) controls the instrument via the USB port using the following settings:

USB specification:	USB 1.1	
USB baud rate:	12 Mbit/s (full speed mode)	
USB Vendor ID:	2496	(0x09C0)
USB Product ID:	347	(0x015B)
USB device class:	Communication Device Class (CDC)	

The host computer communicates with an embedded master controller firmware via the USB connection using asynchronous ASCII transmissions to a virtual serial port.

Command Format

Document Conventions

Table E-1: Command Formatting

CAPS ITALICIZED	Command names
|	Indicates the possible choices for that argument
,	A comma separates the arguments. In the instrument, arguments are space delimited; therefore the comma is shown here only for clarity
italicized	Command arguments
ON	An argument in all capital letters, such as ON, implies that a literal string is required.
CRLF	Carriage Return and Line feed characters ('\r\n')

All commands must follow the format:

/*CMD_NAME* [*command_args*] CR

- '/' (Forward slash) indicates start of a new command and clears firmware command buffer. It is optional and can be omitted.
- *CMD_NAME* is a command name separated from command_args by a white space.
- *Command_args* is a list of zero or more arguments, each separated by white space.
- CR is the end-of-command character

Commands and arguments are not case sensitive.

It is acceptable, but not required, to allow commands to be abbreviated with a minimum 4 characters to uniquely identify the command. The commands will be searched in alphabetical order. The first match will be the selected command.

String arguments must not include the prohibited characters: CR LF TAB / < > \ ? * : | " .

String arguments can be enclosed in double quotes.

No Error (OK) Responses

Valid commands with no response data and empty lines will be acknowledged by the "no data OK" response:

OKTABCRLF>

Where OKTAB identifies the no error response terminated by the character (>) and CRLF added for better readability in terminal applications.

Data returned by a command begin with OKTAB (no error prefix) and is terminated by the regular response terminator character (>).

For example: a successful *READ VERSION* command returns:

OKTAB W1.0.4 CRLF>

Error Responses

Unknown commands, commands with invalid numbers or types of arguments, and commands which are unable to immediately perform their function are acknowledged by the response:

FAILTABxxx {"text"}CRLF>

Where character FAIL identifies the error response and xxx represents the decimal error code followed by the optional text message string separated by double-quote characters and terminated by the CRLF>.

In case of an error response, status of the instrument should be acquired by the status command. If the instrument is unable to continue to operate properly, for example, because of a motor stall or a sensor fault, you must reset the instrument.

General Commands

Initialization

Reset

Command: */RESET [no arg]*

Action:	Resets the washer. Stops pumps, closes all valves, homes all axes, and moves the plate carrier to the loaded position. It requires polling of the instrument status for completion with "/status" command.
Response:	"No data OK" response if the command succeeds.

Software Reset

Command: */SOFTRES* [no arg]

Action:	Restores the instrument to turned on state without disrupting the current communications connection, it does not home axes.
Response:	"No data OK" response if the command succeeds.

Device Information

Version

Command: /*VERSION* [no arg]

Action:	Sends and returns current master controller, GUI and motor controller firmware versions. It also sends the StakMax® firmware version if present.
Response:	Returns current master controller and GUI firmware versions – ASCII string representing firmware versions in <id><major>.<minor>.<build> format.
Example:	OKTABW1.2.3 X1.2.3 W1.2.3 STK:1.2.3CRLF>, where 'W1.2.3' represents the current master controller, 'X1.2.3' current GUI, 'W1.2.3' current motor controller, and 'STK:1.2.3' current StakMax firmware versions.

Name

Command: /*NAME* [no arg]

Action:	Returns the name and model of the instrument.
Response:	Name and model ASCII string, "AquaMax 2000" or "AquaMax 4000".
Example:	OKTABAquaMax 4000CRLF>

Serial Number

Command: /*SERIAL* [no arg]

Action:	Returns the serial number of the instrument.
Response:	Serial number as an ASCII string.
Example:	OKTABAQ4K01001CRLF>

Status

Command: */STATUS* [no arg | y | z]

Action:		Provides information describing either the status of the other instrument (no arguments) or the requested axis status:
Response	IDLE	the instrument or AXTS is idle, no errors, ready to run.
	BUSY nm	a protocol or a single command is being executed (for example, axis is moving).
	FAULT nm	the instrument or AXTS cannot operate properly, possible motion fault (axis stalled). It requires RESET command to continue.
	PAUSE nm	an instrument or AXTS is paused waiting for a user input - "Pause 0" to continue or "Stop" to cancel or stop the action.
Response:	Where	
		<n> is a report flag: "1" = a new report message is available, "0" = no news.
		<m> is an index of the running protocol. A single-action command in progress returns the step number as "-1".
Example:		OKTABIDLECRLF>; OKTABBUSY 0 3CRLF>; OKTABBUSY 1 3CRLF>

State Report

Command: /*REPORT* [no arg]

Action:	Returns a text message describing the current action in progress or status.
Response:	"text message" n m Where n is an action flag: (-127) = display post-program user message (in Pause state). (-2) = display pre-program user message (in Pause state). (-1) = load a plate to wash position. 0 = single action command or first step of program in progress. 1-(N-1) = program step in progress. (N) = unload a plate to eject position, where N = number of program steps. and where m is a step repeat count: "0" indicates first time the step is executed. "1" indicates second time the step is executed, and so on.
Example:	OKTAB "Ejecting a plate…"-2 0CRLF> OKTAB"Aspirating …"0 0CRLF> OKTAB"Resetting the instrument"0 0CRLF>

Help

Command: /*HELP [no arg | cmd_name]*

Action:	Returns a list of supported commands [no arg] or help on the selected command [cmd_name].

Motion Control

Eject a Plate

Command: /*EJECT [no arg | (0 | 1)]*

Action:		Ejects or loads the plate, reports current "eject" position.
	[no arg]:	Returns current "eject" position (= 0 if plate is loaded, = 1 if plate is ejected).
	[0]:	Load plate. Moves the plate carrier to wash position (lifts the head to unload position first).
	[1]:	Eject plate. Moves the plate carrier to loading position (lifts the head to unload position first).
Response:		"No data OK" response if the command succeeds if (0 | 1) argument is present.
		Reports an eject state "0" or "1" when no arguments specified.

Response: Emergency Stop = STOP BUTTON

Command: /*HALT [no arg]* = Stop button

Action:	In an emergency case, it immediately halts any running protocol or command, releases pressure, closes all valves, turns off pumps, and removes power from all axes.
Response:	"No data OK" response if the command succeeds.

Stop (Abort) = Cancel button

Command: /*STOP [no arg]*

Action:	Stops the currently running protocol, stops the running step, and moves the plate carriage to the eject position.
Response:	"No data OK" response if the command succeeds.

Program Control

Pause / Resume

Command: /*PAUSE [no arg | 0 | 1]*

Action:	Temporarily pauses (or resumes) execution of a running program.
	[no arg]: Reports current state.
	[0]: Resumes execution of a paused program.
	[1]: Requests a pause. The program is paused and the status reports PAUSE only after the current step is done. In PAUSE state, a program waits for the "/pause 0" command from the host to proceed to the next step.

Note: Firmware switches to PAUSE state to display start/stop program user messages and report situations requiring user intervention. For example, when a waste bottle is full. It expects to receive "/pause 0" to resume or "/stop" to stop a program.

Response:

Shutdown

Command: */SHUTDOWN [no arg | Proc {Inlet}]*

| Action: | The command runs the instrument shutdown procedure. |

> **Note:** The command returns an error if the instrument status is busy running a program or motion command.

> **Note:** When the shutdown starts, the firmware resets the LCD screen so that the backlight turns off when the shutdown completes.

[no arg]:	Returns "1" if shutdown is in progress, "0" if otherwise.
[Proc, {Inlet}]:	
[0]:	Depressurizes bottles.
[1]:	Rinses Inlet and then depressurizes bottles.
[2]:	Purges and then depressurizes bottles.
[3]:	Rinses Inlet and then purges and depressurizes bottles.
Response:	"No data OK" response if the command succeeds.

User Adjustment

Liquid Factor

Command: /*LIQF [no arg | P0 {P1 P2 P3}]*

Action:	For currently open protocols, specifies a liquid factor value to adjust effective dispense time for a specified inlet for any dispense (wash) step in 50-200[%] of the calculated nominal. This command returns an error if no protocol is open.
	Adjustment value 100% sets nominal calculated dispense time (no correction).
	A value of 100-200% increases (x1.0-2.0) and value 50-99% decreases (x0.5-0.99) dispense time for an inlet.
	[no arg]: Reads the liquid factor adjustment values for all inlets.
	[P0]: Value [%] of nominal dispense time for inlet 0 (green).
	[P1]: Value [%] of nominal dispense time for inlet 1 (red).
	[P2]: Value [%] of nominal dispense time for inlet 2 (blue).
	[P3]: Value [%] of nominal dispense time for inlet 3 (yellow).
Response:	"No data OK" response if the command succeeds.
Example:	/*LIQF* 100 50 100 200CRLF to decrease dispense time for red to 50% and increase yellow inlet to 200% of the nominal (calculated) time.
	/*LIQF*CRLF returns OKTAB 100 50 100 200CRLF>

Program Management Commands

You create programs to wash plates and perform maintenance. These programs or protocols are composed of basic primitives for wash functions (dispense, aspirate, wash, shake), program control (soak/pause, repeat), or maintenance functions (prime, purge, rinse). Firmware maintains these protocols in non-volatile storage, with a total of 103 slots available.

You edit the protocols by adding, deleting, and replacing step primitives using the following commands.

All step primitives in any protocol share the same plate type (from an editable plate library).

Factory-defined Protocols

Factory-defined one-touch protocols (programs) are dedicated to instrument maintenance: rinsing, cleaning, priming. These protocols are composed of the same primitives as regular user programs.

The one-touch protocols provide easy access to common maintenance operations and can be customized like any other program. The default programs offer a functional method to perform the named method. You can edit these protocols in the same way as other programs but the names **One-touch Prime**, **One-touch Clean**, and **One-touch Rinse** cannot be changed. The one-touch protocols are stored in slots 0-2.

Protocol (Program) Control

Command: */PROTOCOL* [*<Index> | Run <index>| Open | Close <save>| New <name>| Delete <index>| Copy <index> <name>| Rename <index> <name>| Get <m>| Set <m> <Args>*]

Action:	Edits and views the stored protocol list. Used in conjunction with the /step command to edit protocol steps.
Index Action:	Read protocol name, where Index is a decimal number [0-102].
Index Response:	"No data OK" response if protocol does not exist, "protocol name" <k> <m> <n> if the protocol exists, where:
	<k> is the total number of steps.
	<m> is the "dirty" flag: 0 = valid plate attached, 1 = attached plate settings have changed since protocol was saved (protocol is not executable until it has been saved again).
	<n> is the attached plate geometry: 0 = 96 wells, 1 = 384 wells.
Index Example:	/prot 0 returns OKTAB"My protocol #1" 5 0 1CRLF>
Run Action:	Executes <index> protocol.
Run Response:	"No data OK" response if the command succeeds.
Open Action:	Opens <index> the protocol for viewing or editing.
Open Response:	"No data OK" response if the command succeeds.
Close Action:	Closes access to the opened protocol. <Save> is a Boolean to save protocol (1) or to discard changes (0).

Close Response:	"No data OK" response if the command succeeds.
New Action:	Creates a new blank protocol with the name set to <name>. <Name> is limited to 19 characters. Default program settings are: no start or end messages, "no-plate" attached, manual stacker mode, no restacking.
New Response:	Returns index of the new protocol if command succeeds.
New Example:	/prot new "My New Protocol"CRLF returns OKTAB4CRLF>
Delete Action:	Deletes Index protocol. One-touch protocols 0-2 cannot be deleted. All other protocol indexes can change after a successful delete.
Delete Response:	"No data OK" response if the command succeeds.
Copy Action:	Creates a copy of <index> protocol with the name set to <name>. <Name> is limited to 19 characters. Default program settings are: no start or end messages, "no-plate" attached, manual stacker mode, no restacking.
Copy Response:	Returns index of the copied protocol if command succeeds.
Copy Example:	/prot copy 3 "Copied Protocol"CRLF returns OKTAB5CRLF>

Rename Action:	Renames Index protocol to <name>. One-touch protocols 0-2 cannot be renamed.
Rename Response:	"No data OK" response if the command succeeds.
Get Action:	Reads a field, <m>, from the open protocol settings, where <m> is 0 = start message, 1 = end message, 2 = protocol parameters. A protocol must be opened (/protocol open) before /protocol get can succeed.
Get Response:	Returns the start or end messages (<m>=0 or 1) or the parameter list. The parameter list consists of single character tokens followed by the token value, where the tokens are:

P: Plate ID, 0-31 or -1 for "no plate".

F: Dirty flag (128 = dirty, 0 = OK), indicating the attached plate has changed since the protocol was last stored.

M: Stacker mode (0 = manual, 1 = automatic, use stacker if attached).

R: Restack mode (0 = no restacking, 1 = restack plates after protocol completes with a stack of plates).

Get Example:	/prot get 0CRreturns OKTAB"Hello world" CRLF>
	/prot get 2CRreturns OKTABP2 F0 M0 R0CRLF>

Set Action:	Sets a field, <m>, of the open protocol settings, where <m> is 0 = start message, 1 = end message, 2 = protocol parameters. A protocol must be opened (/protocol open) before /protocol set can succeed.

The <Args> parameter for set 0 and set 1 is the start or end message enclosed in double quotes.

The <Args> parameter for set 2 is a list of single character tokens followed by the token value, where the tokens are:

P: Plate ID, 0-31 or -1 for "no plate".

M: Stacker mode (0 = manual, 1 = automatic, use stacker if attached).

R: Restack mode (0 = no restacking, 1 = restack plates after protocol completes with a stack of plates).

Set Response:	"No data OK" response if the command succeeds.
Set Example:	/prot set 0 "Hello world"CR sets the start message.

/prot set 2 P2 M1 R1CRsets the plate to type 2, automatic stacking and restacking on.

/prot set 2 P-1 M0CRsets the plate to type to "no plate" (only maintenance steps available) and manual plate delivery.

Edit/view Opened Protocol Steps

Command: */STEP [New <index>| Delete <index>| Default <code>| Get <index>| Set <index> <code> <tokens>]*

Action:	Edits and views steps of the currently open protocol (/protocol open). The first parameter defines the specific action. Step indices range from 0–49.

New Action: Creates a new blank step at the specified <index>. Former steps <index> and greater are incremented.

New Response: "No data OK" response if the command succeeds.

Delete Action: Deletes <index> step. Existing subsequent steps are decremented.

Delete Response: "No data OK" response if the command succeeds.

Default Action: Reads the default settings of <code> step type, where <code> is as described in section {Function-specific Step Arguments and Return Data}.

Default Response: Returns the step parameter list in the format of <tokens> as described in section {Function-specific Step Arguments and Return Data}.

Get Action: Reads the settings of the <index> step.

Get Response: "No data OK" response if step does not exist, <code> <tokens> if the protocol exists, where <code> and <tokens> are as described in section {Function-specific Step Arguments and Return Data}.

Set Action: Sets the settings of the <index> step, using the <code> and <tokens>, where <code> and <tokens> are as described in section {Function-specific Step Arguments and Return Data}.

Set Response: "No data OK" response if the command succeeds.

Function-specific Step Arguments and Return Data

The <*code*> and <*tokens*> parameters of the /*STEP* command and response are mnemonics for protocol steps primitives and required parameters.

<Code> is one of the following step types (all are four characters except nop):

disp	dispense
aspi	aspirate
wash	wash
shak	shake
soak	soak (wait)
repe	repeat
prim	prime
purg	purge
stan	standby
rflu	rinse-flush
nop	blank (no operation)
whsq	fast wash

<Tokens> is the step parameter list in the format of single letter tokens followed by corresponding (integer) values, where the tokens are:

I	inlet number, 0-3 (0=green, 1=red, 2=blue, 3=yellow), -1 (prompt)
R	rate, generally 0-4
T	time, seconds
U	time, tenths of seconds
V	volume, microliters/well

M   mode

S   speed

A   address (index) of another step

N   number

Dispense (DISP)

Dispense step delivers a specified amount of fluid into the plate. The dispense needles are moved to just above the top of the plate and the requested horizontal position.The appropriate dispense valve is opened for a calculated time to deliver the specified volume at the specified flow rate.

For dispense rates available through the user interface, see Table 4-9: Plate Wash and Cell Wash Dispense Rates on page 48.

Parameter tokens are:

I   inlet number, 0-3 (0=green, 1=red, 2=blue, 3=yellow), -1 (prompt)

R   Rate: Dispense rate (5 head specific pressure levels, 0=lowest, 4=highest, corresponding to the user interface settings 1 to 5)

V   Volume: Dispense volume per well 20- 400 (96-well), 5-150 (384-well) [μL]

Example: /STEP set 5 DISP i0 r2 v350CR, response is OKTABCRLF>

                /STEP get 5CR, response: OKTABDISP I0 R2 V350CRLF>

Aspirate (ASPI)

Aspiration removes fluid from the plate. Vacuum begins prior to the needles coming into contact with the liquid surface. Vacuum continues as the needles descend at the specified rate to the specified position. The needles are left at the specified height for the specified time. The needles are withdrawn from the wells at a predefined rate. Then vacuum is stopped after the needles are above the wells. For crosswise aspiration the head descends to the specified height and then moves the plate horizontally from edge to edge of their wells relative to needle horizontal position for the specified time.

For aspirate rates available through the user interface, see Table 4-11: Aspiration Rates on page 50.

Parameter tokens are:

M	Mode: 0=center, 1=edge, 2=crosswise motion from edge to edge
R	Rate: Aspiration (vacuum) rate [0-4]: 0=lowest, 4=highest vacuum, corresponding to rates 1 to 5 in the user interface
S	Speed: Probe descent speed [0-2]: 0=slow, 1=medium, 2=fast
H	Aspiration height from a plate bottom [μm]
U	Time: Aspiration time 0-300 [0.1 sec]

Example: /STEP set 4 ASPI M0 R1 S2 T60CR, response OKTABCRLF>

/STEP get 4 CR, response: OKTAB ASPI M0 R1 S2 T60 CRLF>

Wash (WASH)

Washing is simultaneous aspiration and dispensing. Aspiration begins as with whole plate aspiration. However when the aspiration needles reach the specified height, dispensing begins. No crosswise aspiration is allowed in this mode. The aspiration rate should be greater than the dispense rate. The simultaneous aspiration and dispensing continues for the specified dispense volume. Aspiration then continues as the needles are withdrawn from the wells as with whole plate aspiration.

For wash rates available through the user interface, see Table 4-13: Wash Rates on page 51.

Parameter tokens are:

I   Inlet: [0-3], 0=green, 1= red, 2=blue, 3=yellow, -1=prompt

R   Rate: Aspirate/Dispense wash rate [0-1]: 0=gentle, 1=fast

V   Volume: Dispense volume 50-3000 [µL per well]

H   wash height: 0= plate bottom, 1= plate top

Example: /STEP set 3 WASH I2 R0 V3500CR returns OKTABCRLF>

                 /STEP get 3 returns OKTABWASH I2 R0 V3500 CRLF>

Fast Wash (WHSQ)

Washing is sequential aspiration and dispensing. Aspiration at the highest rate begins as with whole plate aspiration. After the aspiration needles reach the specified height and the dwell period expires, the head starts moving up and dispensing begins. The dispensing continues until the specified volume per cycle is dispensed. Aspiration continues as the needles move down to the specified height. Then the cycle repeats.

This mode does not support non-flat bottom plates or crosswise aspiration.

Parameter tokens are:

I	Inlet: 0=green, 1=red, 2=blue, 3=yellow, -1=prompt
R	Dispense rate [1 to 5]: 1=gentle, 5=fast
V	Dispense volume: 20-400 [µL per well per cycle]
H	Aspiration height from a plate bottom: [0 µm to well depth]
U	Dwell time: Aspiration time0 to 25.5 [x 0.1 sec]
N	Number of cycles: [1 to 255]

Example: /step set 3 SQWH 12 R0 V300 H1000 U0 N3CR returns OKTABCRLF>

/step get 3 returns OKTABSQWH 12 R0 V300 H1000 U0 N3CRLF>

Shake (SHAK)

The plate is shaken for the specified time at the given intensity level. Shaking is linear only (along horizontal axis).
Parameter tokens are:

S   Speed: 0 =slow, 1=medium, 2=fast

T   Time: 1-600 [sec]

Example: /step set 2 SHAK T120CR returns OKTABCRLF>

              /step get 2 CR returns OKTABSHAK T120 CRLF>

Soak / Wait (SOAK)

Needles are removed from the wells and no other operations are performed for the specified time.
Parameter tokens are:

T   Time: 1-7200 [sec]

Example: /step set 2 SOAK T60 CR returns OKTABCRLF>

              /step get 2 CR returns OKTAB SOAK T60CRLF>

Repeat (REPE)

The protocol repeats steps from the specified first step to the repeat command in order, the specified number of times. Firmware supports up to 8 repeat loops per protocol.

Parameter tokens are:

A   Address (index) to repeat from [0-49]

N   Number of repetitions [1-99]

Example: /STEP set 1 REPE A0 N2CR returns OKTABCRLF>

                  /STEP get 1 CR returns OKTABREPEAT A0 N2CRLF>

Prime (PRIM)

Prime fills the internal fluid path with the specified fluid and removes bubbles. This is similar to whole plate dispensing except that the fluid is sent to waste and the wash vacuum valve is used to backfill the manifold. Full prime is used when the system has been purged prior to prime. Maintenance prime is used when changing inlets or other fluid is already in the system.

Parameter tokens are:

I   Inlet: [0-3], 0= green, 1= red, 2=blue, 3=yellow, -1= prompt

R   Rate: Prime type [0-1]: 0=Maintenance (~150 mL), 1 =full (~350 mL)

Example: /STEP set 0 PRIM I2 R0CR returns OKTABCRLF>

                  /STEP get 0 CR returns OKTABPRIM I2 R0CRLF>

Purge (PURG)

Purge removes all fluid from the internal fluidics path. The vacuum valves are opened in the wash manifold and waste trough to remove all liquid.

Parameter tokens are: none

Example: /STEP set 1 PURG CR returns OK TAB CRLF >

/STEP get 1 CR returns OK TAB PURG CRLF >

Standby (STAN)

Standby step fills the prime/soak trough with a rinse fluid and leaves the dispense tips in the rinse fluid. At the specified refresh interval, the trough is drained and refilled with the rinse fluid. When you stop the operation normally (through a user interface selection), the trough is drained and a small amount of fluid is rinsed (dispensed) through the dispense needles.

Parameter tokens are:

I   Inlet: [0-3], 0= green, 1= red, 2=blue, 3=yellow, -1= prompt

T   Time: Refresh interval, 1-86400 [sec], (-1)= never

Example: / STEP set 2 STAN I2 T60 CR returns OK TAB CRLF >

/ STEP get 2 CR returns OK TAB STAN I2 T7200 CRLF >

Note: This step primitive runs until "Stop" command is received. Upon completion firmware drains the trough.

Note: Firmware stores the standby interval as 16-bit word in minutes (1-1440).

Rinse-flush (RFLU)

Rinse-flush step rinses all common fluidics (prime/soak trough, head, valves) with fluid from the requested inlet. Upon completion the head is left empty.

Parameter tokens are:

I	Inlet: [0-3], 0= green, 1= red, 2=blue, 3=yellow, -1= prompt

Example:	/step set 2 RFLU i0 CR returns OKTAB CRLF>
	/step get 2CR returns OKTAB RFLU i0 CRLF>

No Operation (NOP)

Skip the step.
Parameter tokens: none

Example:	/set 5 NOPCR, /get 5 CR returns OKTABNOPCRLF>

Execute Step

Command: /EXEC [PURGE | STAN {tokens}]

Action:	Execute a single step primitive without creating a protocol. This command supports only purge and standby steps. The PURGE and STAN options act identical to the corresponding steps.

Plate Library Access

The plate library stores up to 32 plate descriptions (indexed 0-31). Plate descriptions include a unique configuration ID, the plate name, number of wells, well geometry (flat, V-bottom, U-bottom, small volume), plate height, and well depth.

The first 8 plates, though editable, are set to factory default values listed in Table E-2.

Table E-2: Factory Defaults

Index	Name	# Wells	Bottom	Height (µm)	Depth (µm)
0	Costar96	96	Flat	14200	10670
1	Falcon96	96	Flat	14250	10590
2	Greiner96	96	Flat	14400	10900
3	Nunc96	96	Flat	14800	12500
4	Costar384	384	Flat	14200	11430
5	Falcon384	384	Flat	14320	11500
6	Greiner384	384	Flat	14400	11500
7	Nunc384	384	Flat	14400	11700

Command: */PLATE [{} | <plate> | Index <id>| Select <index>| New <name>| Ren <index> <name>| Del <index>| Get <index>| Set <index> <Args>| Used <index>| Auto <type>]*

Action: Edits and views the stored plate library.

{} Action: If no argument is used, reads selected plate's description.

{} Response*:* Returns the configuration ID, name, and formatted parameters of the selected plate.

{} Example*:* /plate returns OK<small>TAB</small> 9 "384-well flat plate" <small>CRLF</small> wells: 384 height: 10000[um] depth: 5000[um] <small>CRLF</small>>

<plate> Action*:*	Reads the specified plate's configuration ID and its name.
<plate> Response*:*	Returns the configuration ID and name of the plate at index <plate>. If the index does not contain a plate, the "no data OK" response is returned.
<plate> Example*:*	/plate 8 returns OKTAB 14 "My plate" CRLF>

Index Action*:*	Provides runtime conversion from a configuration ID to the corresponding plate Index.
Index Response*:*	Returns the plate index or -1 if the plate is not found.
Index Example*:*	/plate index 14 returns OKTAB 8 CRLF>

Select Action*:*	If <plate> is given, selects <plate> index and sets plate specific hardware offsets (requires compatible wash head installed).
Select Response*:*	Returns "No data OK" response if <plate> is given, otherwise returns the configuration ID of the selected plate or -1 if no plate is selected.
Select Example*:*	/plate select 8 returns OKTAB CRLF> /plate select returns OKTAB 14 CRLF>

New Action*:*	Adds a new plate description at the end of the plate list, with new name <name>, given in double quotes and limited to 19 characters.
New Response*:*	Returns the index of the new plate description.
New Example*:*	/plate new "another plate" returns OKTAB 10 CRLF>

Ren Action*:*   Renames <index> plate to <name>, given in double quotes and limited to 19 characters.

Ren
Response*:*   "No data OK" response if the command succeeds.

Del Action*:*   Deletes <index> plate.

Del
Response*:*   "No data OK" response if the command succeeds.

Get Action*:*   Reads the <index> plate description parameters.

Get
Response*:*   Returns the parameters as a list of single character tokens followed by the integer token value, where the tokens are:

W: Plate well type: 0 = 96 wells, 1 = 384 wells.

B: Bottom shape: 0 = flat, 1 = U-bottom, 2 = V-bottom, 3 = small volume.

D: Well depth, microns (0-plate height).

H: Plate height, microns (7500-25500).

Get Example*:*   /plate get 2CR returns OKTAB W0 B0 D14400 H10900CRLF>

Set Action*:*   Sets the <index> plate description parameters to the values given in <Args>. <Args> is a list of single character tokens followed by the integer token value, where the tokens are:

W: Plate well type: 0 = 96 wells, 1 = 384 wells.

B: Bottom shape: 0 = flat, 1 = U-bottom, 2 = V-bottom, 3 = small volume.

D: Well depth, microns.

H: Plate height, microns.

Set Response*:*	"No data OK" response if the command succeeds.
Set Example*:*	/plate set 8 W0 B1 D5000 H10000CR returns OKTAB CRLF>

Used Action*:*	Determines the total number of programs (protocols) currently using the <index> plate.
Used Response*:*	Returns the number of programs.
Used Example*:*	/plate used 8 returns OKTAB 1 CRLF>

Auto Action*:*	Starts automatic well-bottom detection routine, if <type> is given, or provides last determined well depth. The <type> parameter describes the plate type, 0 for 96-well or 1 for 384-well.
Auto Response*:*	"No data OK" response if command succeeds. If <type> is omitted, the last determined well depth is returned or 0 if the procedure failed. The well depth value determined by '/plate auto' is not stored in any plate index. Use '/plate set' to store the well depth.
Auto Example*:*	/plate auto 0 CR starts automatic detection and returns OK TAB CRLF>
	/plate auto CR returns OK TAB 8512 CRLF>

StakMax® Robot Control

The StakMax robot is automatically detected by the washer during power-on initialization. The AquaMax Microplate Washer controls the StakMax Plate Stacker via the StakMax communication port connection.

Stacker Control

Command: /*STACKER* [*{}* | *Init*, *Restack*, *Load 0|1* | *Plates* | *Barcode*].

Action:	Controls the StakMax stacker.
{} Action:	Detects whether the StakMax stacker is connected to the StakMax port.
{} Response:	Returns "1"= StakMax stacker detected, "0"= not detected.
	Firmware polls for a StakMax presence every 1 second when the instrument is in IDLE state sending /STATUS command to StakMax port.
{} Example:	/STATUS returns OKTAB FAULT 1 0CRLF>; stacker is not connected
Init Action:	Initializes the StakMax stacker.
Init Response:	"No data OK" response if the command succeeds.
Init Example:	/STACK INITCRLF returns OKTABCRLF>; command is accepted by the AquaMax Microplate Washer
Restack Action:	Restacks plates from stack B to A after running a program.
Restack Response:	"No data OK" response if the command succeeds.

Load
Action:

"1" = Load a plate from stack A, "0" = unload a plate from the AquaMax Microplate Washer to stack B.

Load
Response:

"No data OK" response if the command succeeds.

Plates
Action:

Returns the number of plates successfully loaded from the StakMax stacker by running the protocol. The number changes when a plate is loaded from the StakMax stacker and its barcode (if present) is read. Host software can use this command to poll progress of automatic plate loading to retrieve the loaded plate barcode.

Plates
Example:

/STACK PLATESCRLF returns OKTAB 1 CRLF>; 1 plate was loaded from StakMax stacker

/STACK PLATESCRLF returns OKTAB 2 CRLF>; 2nd plate is loaded from StakMax stacker

Barcode
Action:

Returns the barcode string read by the StakMax stacker enclosed by double quotes (if available). The string is cleared at the start of the plate load (return "") and updated from the StakMax stacker barcode reader when the plate is successfully loaded to the AquaMax Microplate Washer (loaded plate number is incremented). If the StakMax stacker is unable to read the barcode command returns "NO BARCODE AVAIL" string.

The command with an argument requires polling the washer status for move completion until it is not BUSY. Status IDLE indicates success, FAULT – if stacker move has failed.

Barcode
Example:

/STACK BARCODECRLF returns OKTAB "NO BARCODE AVAIL" CRLF>; the barcode is not available

/STACK BARCODECRLF returns OKTAB "" CRLF> plate loading from the StakMax stacker is in progress, the barcode is not read yet

/STACK BARCODECRLF returns OKTAB "21-60371-01" CRLF>; return the barcode from the last loaded plate

Example:

/REPORT returns OKTAB "StakMax command timeout [190]" -2 0 CRLF>

Errors

Errors that arise during runtime are stored in an error buffer. The error buffer is maintained in non-volatile memory, so all error messages will survive an instrument power cycle or reset.

The error buffer is a circular first-in, first-out list with 128 elements. When full, additional errors overwrite the earliest error and an "error buffer is full" warning is logged.

To minimize the likelihood of overflowing the error buffer, an error count mechanism reports consecutively repeated errors. The count is displayed at the end of the error string. For example: "<error code> <message><boot count> (nnn times)"

Error Reporting

/ERROR [*Last, List | Number | n | Count | Clear*]

no argument	Displays all of the errors in chronological order. The format is as follows:
	current boot count {#bootcount} firmware {version} CRLF.
	#error code {message} ({#bootcount}) ({# of occurrences} times) CRLF.
Last	Displays the code of the last error in the buffer. If no argument is given, the last error code is displayed. If there is an argument, the last n errors are given.
List	Displays a list of all error numbers and descriptive text.
Number	Displays the contents of the error log in numeric form. Only error numbers and occurrence count are returned.
n	Displays the nth error in the log with its ASCII string. An index value of COUNT is the most recent error and index value of zero displays the oldest error.
Count	Displays the number of errors in the log.
Clear	Clears the error log.

Error Recovery

Errors ³ 600 are caused by improper input. No recovery is required. The error prevented instrument operation. Instrument operation continues with the next valid command.

Errors between 100 and 199 permit continued operations. Continued operation is possible following acknowledgement and/or correction of the error. For example: empty waste container to correct waste full error.

Errors between 200 and 299 or less than 100 are Fatal Errors: only status commands are available. A reset is required for continued operation.

Instrument Response

The host computer should receive a response from a directly connected instrument within 1 second. If no response is received within the allowed time, the host computer should generate a timing error and can assume that the microplate washer is not connected or not functioning properly.

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