
MAXline

Microplate Readers

(E_{max}[™], V_{max}[®], and THERMO_{max}[™])

User's Manual



**Molecular
Devices**

Molecular Devices Corporation
Sunnyvale, California 94089

Part # 0112-0031

Rev. A



Molecular Devices Corporation

Series 1 Instruments User's Manual

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Emax Specifications

Photometric Performance

Measurement Range	0.000 to 4.000 OD (400–750 nm)
Read Time (96 well microplate)	Read Only: 5 Seconds Calibration: 5 Seconds
Resolution	0.001 OD (400–750 nm)

Accuracy

Wavelength Range	Absorbance Range (OD)	Accuracy
400 nm – 750 nm	0.000 to 2.000	$\pm (1.0\% + 0.010 \text{ OD})$
445 nm – <485 nm	2.001 to 2.500	$\pm (1.5\% + 0.010 \text{ OD})$
485 nm – 750 nm	2.001 to 3.000	$\pm (1.0\% + 0.010 \text{ OD})$

Precision (Repeatability)

Wavelength Range	Absorbance Range (OD)	Accuracy
400 nm – 750 nm	0.000 to 2.000	$\pm (1.0\% + 0.005 \text{ OD})$
445 nm – <485 nm	2.001 to 2.500	$\pm (1.5\% + 0.005 \text{ OD})$
485 nm – 750 nm	2.001 to 3.000	$\pm (1.0\% + 0.005 \text{ OD})$

Emax Instrument

Calculated Mean Time Between Failure (MTBF)	>50,000 hours
Light Source	Tungsten krypton (5 watts)
Average Light Source Lifetime	>4000 hours
Calibration	Self calibrating
Drift	Zero due to digital signal processing.
Optical Alignment	None required during lifetime of instrument.
Photodetectors	96 Silicon (UV enhanced)
Filter Capacity	Six
Optical Filters Supplied	405, 450, 490, 650 nm (10 nm bandwidth typical)

Filter Range Available	400–750 nm
Filter Structure	Three cavity interference filter with enhanced blocking.
Reading Chamber	Light-tight during reads and calibration.
Control Panel	11 direct keys plus 3 shift key functions displayed on an easy-to-use touch membrane.
Computer Interface	RS232 (bidirectional control)
Printer Interface	Centronics parallel
Microplate Carrier	Accommodates all 96-well microplates including strip wells (8's and 12's) and filter-bottom microplates.
Reading Chamber Temperature Variation	$\leq \pm 1.0^{\circ}\text{C}$ of ambient
Well-To-Well Temperature Variation	$\leq \pm 0.4^{\circ}\text{C}$ measured on air within the reading chamber.
Thermoregulation	Emax may be operated inside an incubator.
Warm-Up Time to Meet Specifications	<30 seconds

Emax On-Board Features and Capabilities

Photometric Analysis Modes	<ul style="list-style-type: none"> • Single wavelength, Optical Density • Dual wavelength, Optical Density • Range • Blank Pattern
Extended OD Range	OD range may be set to read from 0.000 to 4.000 OD.
Speed Read	Enables faster read cycle.
User Interface	Controls on the control panel are direct, requiring no memorization of repertoires of commands to enable specific features and capabilities.
Mini Manual	A built-in one-page guide to operating procedures may be printed on command.
Range	Reports OD values as an integer for qualitative analysis.
Blank Pattern	Blank pattern may be stored and the mean of the blank group subtracted from all 96 wells.
Terminal Output	Data and report formats may be transmitted directly to computer terminals rather than to a printer if required.
Condensation Control	Anti-condensation control in reading chamber.
Stray Light Control	Lenses above and below microplate maximize efficient use of available signal, minimize stray light. Light-tight reading chamber prevents ambient light from striking detectors during reading.

Crosstalk Control	Single well sequential illumination of microplate wells eliminates well-to-well crosstalk of stray light.
Drainage Channels	The drawer mechanism/reading chamber assembly has a drainage port to protect optics from accidental spillage.
On-Board Diagnostics	Continuous on-board self diagnostics ensure proper performance of instrument.

Emax Physical

Size	18-1/4 x 13-3/8 x 7-3/8 inches (47 x 34 x 19 cm)
Weight	22 lb (10.0 kg)
Power Supplies	UL and CE approved
Power Consumption	<35 watts
Line Voltage	90–250 VAC
Line Frequency	50/60 Hz
Operating Temperature	+15 to +40°C (+60 to +105°F)
Operating Humidity	0 to 85% (non-condensing)
Storage	-20 to +65°C (-5 to +150°F)

NOTE: Specifications for Molecular Devices' Microplate Readers are for round and flat bottom microplates. Technical Specifications subject to change without notice.

Vmax Specifications

Photometric Performance

Measurement Range	0.000 to 4.000 OD (400–750 nm)
Read Time (96 well microplate)	
<i>Endpoint:</i>	Read Only: 5 Seconds Calibration: 5 Seconds
<i>Kinetics:</i>	5 second minimum interval between readings
Resolution	0.001 OD (400–750 nm)

Accuracy

Wavelength Range	Absorbance Range (OD)	Accuracy
400 nm – 750 nm	0.000 to 2.000	± (1.0% + 0.010 OD)
445 nm – <485 nm	2.001 to 2.500	± (1.5% + 0.010 OD)
485 nm – 750 nm	2.001 to 3.000	± (1.0% + 0.010 OD)

Precision (Repeatability)

Wavelength Range	Absorbance Range (OD)	Accuracy
400 nm – 750 nm	0.000 to 2.000	± (1.0% + 0.005 OD)
445 nm – <485 nm	2.001 to 2.500	± (1.5% + 0.005 OD)
485 nm – 750 nm	2.001 to 3.000	± (1.0% + 0.005 OD)

Vmax Instrument

Calculated Mean Time Between Failure (MTBF)	>70,000 hours
Light Source	Tungsten krypton (5 watts)
Average Light Source Lifetime	>4000 hours
Calibration	Self calibrating
Drift	Zero due to digital signal processing
Optical Alignment	None required during lifetime of instrument
Photodetectors	96 Silicon (UV enhanced)

Filter Capacity	Six
Optical Filters Supplied	405, 450, 490, 650 nm (10 nm bandwidth typical)
Filter Range Available	400–750 nm
Filter Structure	Three cavity interference filter with enhanced blocking
Reading Chamber	Light-tight during reads and calibration.
Control Panel	13 direct keys plus 3 shift key functions displayed on an easy-to-use touch membrane
Computer Interface	RS232 (bidirectional control)
Printer Interface	Centronics parallel
Microplate Carrier	Accommodates all 96-well microplates including strip wells (8's and 12's) and filter-bottom microplates
Reading Chamber Temperature Variation	$\leq \pm 1.0^{\circ}\text{C}$ of ambient
Well-To-Well Temperature Variation	$\leq \pm 0.4^{\circ}\text{C}$ measured on air within the reading chamber
Thermoregulation	Vmax may be operated inside an incubator
Warm-Up Time to Meet Specifications	<30 seconds

Vmax On-Board Features and Capabilities

Photometric Analysis Modes	<ul style="list-style-type: none"> • Single wavelength, Optical Density • Dual wavelength, Optical Density • Single wavelength Kinetics, Kinetics Graphics • Range • Blank Pattern
Extended OD Range	OD range may be set to read from 0.000 to 4.000 OD.
Kinetic Read Intervals	Intervals between kinetic readings are automatically controlled to maximize collection of data points during the initial linear portion of a kinetic reaction.
Kinetic Automatic OD Cut Off	Kinetic analysis is automatically performed only on readings captured during a 0.200 OD excursion from the first reading.
Kinetic Analysis	Positive or negative kinetic reactions may be monitored. Reaction rates are calculated in milli OD per minute (mOD/min) and printed out in the 8-x-12 microplate format.
Kinetics Graphics	Positive kinetic graphs of raw OD data plotted against the kinetic read time may be printed in the 8-x-12 microplate format. These graphs provide visual verification that the rate value (mOD/min) was calculated during the initial linear portion of the kinetic reaction.

Speed Read	Enables faster read cycle in endpoint mode.
AUTOMix	Automatic mixing of well contents prior to a reading and between readings may be selected.
User Interface	Controls on the control panel are direct, requiring no memorization of repertoires of commands to enable specific features and capabilities.
Mini Manual	A built-in one-page guide to operating procedures may be printed on command.
Range	Reports OD values as an integer for qualitative analysis.
Blank Pattern	Blank pattern may be stored and the mean of the blank group subtracted from all 96 wells.
Terminal Output	Data and report formats may be transmitted directly to computer terminals rather than to a printer if required.
Condensation Control	Anti-condensation control in reading chamber.
Stray Light Control	Lenses above and below microplate maximize efficient use of available signal, minimize stray light. Light-tight reading chamber prevents ambient light from striking detectors during reading.
Crosstalk Control	Single well sequential illumination of microplate wells eliminates well-to-well crosstalk of stray light.
Drainage Channels	The drawer mechanism/reading chamber assembly has a drainage port to protect optics from accidental spillage.
On-Board Diagnostics	Continuous on-board self diagnostics ensure proper performance of instrument.

Vmax Physical

Size	18-1/4 x 13-3/8 x 7-3/8 inches (47 x 34 x 19 cm)
Weight	22 lb (10.0 kg)
Power Supplies	UL and CE approved. Designed to pass VDE.
Power Consumption	< 35 watts
Line Voltage	90–250 VAC
Line Frequency	50/60 Hz
Operating Temperature	+15 to +40°C (+60 to +105°F)
Operating Humidity	0 to 85% (non-condensing)
Storage	-20 to +65°C (-5 to +150°F)

NOTE: Specifications for Molecular Devices' Microplate Readers are for round and flat bottom microplates. Technical Specifications subject to change without notice.

THERMOmax Specifications

Photometric Performance

Measurement Range	0.000 to 4.200 OD (340–750 nm)
Read Time (96 well microplate)	
<i>Endpoint:</i>	Read Only: 5 Seconds Calibration: 5 Seconds
<i>Kinetics:</i>	5 second minimum interval between readings
Resolution	0.001 OD (340–750 nm)

Accuracy

Wavelength Range	Absorbance Range (OD)	Accuracy
400 nm – 750 nm	0.000 to 2.500	$\pm (1.0\% + 0.010 \text{ OD})$
400 nm – <445 nm	2.501 to 3.000	$\pm (2.0\% + 0.010 \text{ OD})$
445 nm – 750 nm	2.501 to 3.000	$\pm (1.0\% + 0.010 \text{ OD})$
340 nm – <400 nm	0.000 to 1.500	$\pm (1.0\% + 0.010 \text{ OD})$
340 nm – <400 nm	1.501 to 2.000	$\pm (2.0\% + 0.010 \text{ OD})$

Precision (Repeatability)

Wavelength Range	Absorbance Range (OD)	Accuracy
400 nm – 750 nm	0.000 to 2.500	$\pm (1.0\% + 0.005 \text{ OD})$
400 nm – <445 nm	2.501 to 3.000	$\pm (2.0\% + 0.005 \text{ OD})$
445 nm – 750 nm	2.501 to 3.000	$\pm (1.0\% + 0.005 \text{ OD})$
340 nm – <400 nm	0.000 to 1.500	$\pm (1.0\% + 0.005 \text{ OD})$
340 nm – <400 nm	1.501 to 2.000	$\pm (2.0\% + 0.005 \text{ OD})$

THERMOmax Instrument

Calculated Mean Time Between Failure (MTBF)	>30,000 hours
Light Source	Tungsten halogen (25 watts)
Average Light Source Lifetime	>750 hours
Calibration	Self calibrating
Drift	Zero due to digital signal processing.
Optical Alignment	None required during lifetime of instrument.
Photodetectors	Silicon (UV enhanced)
Filter Capacity	Six
Optical Filters Supplied	340, 405, 450, 490, 650 nm (10 nm bandwidth typical)
Filter Range Available	340–750 nm
Filter Structure	Three cavity interference filter with enhanced blocking.
Reading Chamber	Light-tight during reads and calibration.
Control Panel	13 direct keys plus 7 shift key functions displayed on an easy-to-use touch membrane.
Computer Interface	RS232 (bidirectional control)
Printer Interface	Centronics parallel
Microplate Carrier	Accommodates standard 96-well microplates and filter-bottom microplates.
Photometric Stabilization	<30 seconds to meet specifications

THERMOmax Temperature Regulation

Well-to-Well Uniformity	Temperature within the chamber will be maintained at the Temperature Set Point and will show thermal uniformity between adjacent wells within $\pm 0.5^{\circ}\text{C}$.
Range	4°C above ambient to 42°C
Chamber Warm-Up Time	<30 minutes from 25 to 37°C at normal operating voltage (120 VAC or 220 VAC)

THERMOmax Temperature Set Point

Range	15.0 to 42.0°C
Resolution	$\pm 0.1^{\circ}\text{C}$
Repeatability	$\pm 0.3^{\circ}\text{C}$
Accuracy	$\pm 0.5^{\circ}\text{C}$
Regulation	$\pm 0.3^{\circ}\text{C}$

THERMOmax On-Board Features and Capabilities

Photometric Analysis Modes	<ul style="list-style-type: none"> • Single wavelength, Optical Density • Dual wavelength, Optical Density • Kinetics, Kinetics Graphics • Range • Blank Pattern • Set Temperature
Extended OD Range	OD range may be set to read from 0.000 to 4.200 OD.
Kinetic Read Intervals	Intervals between kinetic readings are automatically controlled to maximize collection of data points during the initial linear portion of a kinetic reaction.
Kinetic Automatic OD Limit	Kinetic analysis is automatically performed only on readings taken over a change of 0.200 OD from the first reading.
Kinetic Analysis	Positive or negative kinetic reactions may be monitored. Reaction rates are calculated in milli OD per minute (mOD/min) and printed out in the 8-x-12 microplate format.
Kinetics Graphics	Positive or negative kinetic graphs of raw OD data plotted against the kinetic read time may be printed in the 8-x-12 microplate format. These graphs provide visual verification that the rate value (mOD/min) was calculated during the initial linear portion of the kinetic reaction.
Speed Read	Enables faster read cycle in endpoint mode.
AUTOMix	Automatic mixing of well contents prior to a reading and between readings may be selected.
User Interface	Controls on the control panel are direct, requiring no memorization of repertoires of commands to enable specific features and capabilities.
Mini Manual	A built-in one-page guide to operating procedures may be printed on command.
Range	Reports OD values as an integer for qualitative analysis.
Blank Pattern	Blank pattern may be stored and the mean of the blank group subtracted from all 96 wells.
Set Temperature	The temperature set point for the microplate chamber will meet specifications when set between 4°C above ambient to 42°C. The power-up default set point is 37°C.
Temperature Query	The temperature set point and chamber temperature can be displayed at the printer.

Terminal Output	Data and report formats may be transmitted directly to computer terminals rather than to a printer if required.
Solvent Condensation Control	Ventilation of the microplate chamber prevents solvent vapors from condensing on the lenses.
Stray Light Control	Lenses above and below microplate maximize efficient use of available signal, minimize stray light. Light-tight reading chamber prevents ambient light from striking detectors during reading.
Crosstalk Control	Single well sequential illumination of microplate wells eliminates well-to-well crosstalk of stray light.
Drainage Channels	The drawer mechanism/reading chamber assembly is protected from accidental spillage by drainage ports.
On-Board Diagnostics	Continuous on-board self diagnostics ensure proper performance of instrument.
Temperature Regulation Diagnostics	The temperature regulation system is monitored and a warning will be sounded should a failure be detected.

THERMOmax Physical

Size	18-1/4 x 16-1/4 x 7-3/8 inches (47 x 41x 19 cm)
Weight	27 lb (12.3 kg)
Power Supplies	UL and CE approved. Designed to pass VDE.
Power Consumption	<200 watts
Line Voltage	100–120 VAC or 200–240 VAC
Line Frequency	50/60 Hz
Operating Temperature	+15 to +40°C (+60 to +108°F)
Operating Humidity	0 to 85% (non-condensing)
Storage	-20 to +65°C (-5 to +150°F)

NOTE: Specifications for Molecular Devices' Microplate Readers are for round and flat bottom microplates. Technical Specifications subject to change without notice.

Chapter 2 General Description

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Introduction

The Molecular Devices MAXline Microplate Readers are designed to analyze the contents of standard 96-well microplates.

All three instruments (Emax, Vmax, and THERMOmax) measure optical density (OD). The optical array is designed to analyze the absorbance of multiple sample sites with 9-mm centers. Standard 96-well microplates, filter-bottom microplates, and vessels of similar design can be measured in the microplate reader. Sequential illumination of all microplate wells extends the dynamic range and eliminates interference from scattered light which arises from turbid suspensions.

Vmax In addition to measuring optical density (OD), the Vmax Microplate Reader can conduct a kinetic analysis, the rate of optical density change per minute (milliOD/min). This instrument operates over the visible wavelength range from 400 nm to 750 nm.

Tmax The THERMOmax Microplate Reader combines the optical performance of the MAXline Microplate Readers with temperature regulation of the microplate chamber. The THERMOmax Microplate Reader can either measure optical density (OD) or conduct a kinetic analysis, the rate of optical density change per minute (milliOD/min). This instrument can operate over a wavelength range from 340 nm to 750 nm.

Temperature Regulation

The chamber temperature in the Emax and Vmax instruments is ambient and isothermal.

Tmax When the INCUBATOR has not been turned on, the temperature in the THERMOmax microplate chamber is ambient and isothermal. With the incubator on, the temperature of the microplate chamber can be set and regulated from 4°C above ambient to 42.0°C.

Temperature regulation and control of the microplate chamber is achieved through an electric heater, a fan, efficient insulation, a temperature sensor, and the black thermal subplate. The heater is located in the microplate chamber with its placement designed to distribute heat uniformly to the microplate. The microplate chamber is insulated to maintain the Temperature Set Point without heating the electronic components. The sensor is mounted inside the chamber and measures the air temperature.

The heaters are controlled by a solid-state switch and are cycled on and off to maintain the temperature within the microplate chamber. Optimal temperature regulation is achieved by implementing a Proportional/Integral/Derivative (PID) control algorithm. The temperature feedback closed-loop control algorithm measures the chamber air temperature, compares it to the Temperature Set Point, and uses the difference to calculate the heating cycle. This technique results in accurate, precise control of the microplate chamber temperature within the specified temperature range.

Tmax

The THERMOmax distributes the heat uniformly within the microplate chamber by directing heated forced air and by careful location of the heating elements within the microplate chamber.

NOTE: The temperature uniformity within the microplate may depend upon the design, materials, or configuration of the microplate.

Stand-Alone Use

The term “stand-alone” is used to describe operation of any MAXline Microplate Reader without a computer. Operation in the stand-alone mode requires connection to a compatible printer (see “Setting Up for Stand-Alone Use” on page 3-4).

When the MAXline Microplate Reader is operated without a computer, end-point optical density may be read (with resolution of 0.001 OD) using either the single or the dual wavelength capability. The output will be formatted in an 8-x-12 matrix showing the OD readings in the appropriate well locations. Reading in the range mode results in a printout of the read values multiplied by ten and truncated after the decimal point so that only one or two integers are printed.

Vmax

Tmax

The stand-alone configuration also permits kinetic analysis for several total reading times (1, 2, 5, 10 and 20 minutes) selected by the user. Output from kinetic readings is formatted in a similar matrix with the slope values calculated by an on-board, microprocessor-based, linear regression package with output in milli-OD per minute as the unit of measure. A graphic representation of the rate reaction may also be printed. A more detailed description of this feature is given in “Printed Data Output” on page 2-6 and “Read Mode Selection” on page 5-7; see also Figure 2.1 on page 2-7).

In either of these stand-alone modes, the user may select a blank set of wells. The selection of blank wells is accomplished by use of a blank set template and is explained in “Blank Pattern Selection” on page 5-4.

Tmax

The temperature control of the microplate chamber can be left off for end-point readings and ambient kinetic assays or the Incubator may be turned on to regulate the temperature of the microplate chamber from 4°C above ambient to 42°C. The temperature set point for the microplate chamber will default to 37°C or can be set using the blank pattern template. The procedure is explained in “Set Temperature Selection” on page 5-5.

Vmax

Tmax

Automatic mixing of the plate well contents before each read cycle may be selected. This capability allows for valid kinetic analysis of solid phase enzyme-mediated reactions (it is not critical for liquid phase reactions). Elaboration of this capability may be found in the following sections, Endpoint Analysis, (below) and in “AUTOmix Function” on page 5-6.

Endpoint Analysis

If a single set of OD readings for each well of a microplate is required (end-point analysis), either single or dual wavelength operation may be selected. OD readings are reported in the 8-x-12 microplate format.

When dual wavelength is used, readings are taken at a user-selected sample wavelength (λ_1), as well as at a user-selected reference wavelength (λ_2). The differences between these readings are reported for each well and are displayed in a 8-x-12 microplate format.

The sample wavelength is generally chosen to be near the wavelength of maximum absorption (λ_{max}) for the chromophore of interest. The reference wavelength is chosen to be a wavelength at which the chromophore shows relatively little absorption. The dual wavelength feature increases endpoint accuracy because errors arising from optical imperfections such as scratches and plastic irregularity are cancelled out.

When the instrument is used with single wavelength capability in the end-point mode, the five second read cycle is automatically preceded by a calibration cycle (five or six seconds, depending on the instrument). When the dual wavelength capability is employed, a calibration is automatically performed at each of the selected wavelengths. This calibration cycle (for single or dual wavelengths) may be overridden using the Speed Read feature described in “Read Mode Selection” on page 4-6.

Tmax
Vmax If the AUTOMix capability is selected for endpoint readings, the plate is shaken for five seconds prior to the reading. This reduces the need for manual shaking of ELISA (enzyme-linked immunosorbent assay) microplates before reading. OD readings are reported in the 8-x-12 microplate format.

The user also has the choice of selecting range, an endpoint read mode, which reports integer values as described in “Stand-Alone Use” on page 2-4. Range readings are reported in the microplate 8-x-12 format.

During the read cycle, the microplate is maintained in a fixed position in the isothermal reading chamber and all wells are read in a total of five seconds.

Kinetic Analysis

Tmax
Vmax During the read cycle, the microplate is maintained in a fixed position in the isothermal microplate chamber and all wells are read in a total of five or six seconds (for Vmax and THERMOmax, respectively). For rapid kinetic analysis, readings are repeated at intervals as short as five seconds, with the first reading providing the starting OD baseline value for each well.

If the AUTOMix capability is selected for kinetic analysis, the microplate is shaken for ten seconds prior to the initial reading. Thereafter the microplate is shaken for three seconds before each read cycle. This ensures that the color developing in each well is uniformly distributed throughout the well prior to each read.

AUTOMix is strongly recommended for ELISA and other solid-phase enzyme-mediated reactions.

Vmax
Tmax

Both the Vmax and THERMOmax manage the timing of the calibrating, AUTOMix, and read cycles automatically. The instrument determines the initial rate of reaction for each well, either positive (Vmax and THERMOmax) or negative (THERMOmax only) reactions, using a limited OD excursion together with linear regression analysis. Rates are reported as mOD/minute (milli-OD per minute) for each well in the 8-x-12 microplate format.

Kinetic analysis has many advantages for determination of the relative activity of an enzyme in many different microplate assays. These include ELISA tests and purification and characterization of enzymes and enzyme conjugates. Kinetic analysis is capable of providing improved dynamic range, precision and sensitivity relative to endpoint analysis.

Printed Data Output

Data is automatically printed as soon as the plate has been read. When reading a stack of microplates in the endpoint mode, the instrument features a memory buffer handling up to eight separate microplates. This means that microplates can be loaded sequentially and read without pausing for the printer. Printing time is approximately 7.5 seconds per data set when a 200 cps (characters per second) printer is used.

The MAXline Microplate Readers feature printer function keys on the control panel:

- 1) The **[MINI MANUAL]** key prints a one-page summary of operating procedures.
- 2) The **[PRINT AGAIN]** key allows repeated printing of the last set of data.
- 3) The PRINT BLANK PATTERN function, accessed by touching the **[SHIFT]** key and the **[MINI MANUAL]** key (THERMOmax) or the **[PRINT BLANK PATTERN]** key (Emax and Vmax), prints a display of the wells in the current blank set.
- 4) The **[KINETICS GRAPHICS]** key enables a display of rate plots (time versus optical density) for all 96 wells of the last kinetic reading data set either as positive or negative reactions (THERMOmax) or positive kinetic reactions (Vmax). See Figure 2.1 for an example of a negative kinetics graphics printout. Examples of all printouts can be found in "Printout Options" on page 5-11.
- 5) The TEMPERATURE QUERY function, accessed by touching the **[SHIFT]** key and the **[PRINT AGAIN]** key, prints a display of the current chamber temperature and the temperature set point.

Vmax
Tmax

Tmax

<u>MOLECULAR DEVICES</u>				<u>THERMOmax MICROPLATE READER</u>				<u>PLATE #: 1</u>				
ASSAY: _____								DATE: ____/____/____				
OPERATOR: _____								<u>O.D. RANGE:</u> 3.000		TIME: ____:____AM/PM		
<u>WAVELENGTH:</u> 405 nm				<u>AUTO MIX:</u> OFF				<u>CAL:</u> ON				
<u>KINETIC 2 MINUTE RUN</u> (mOD/min)												
	1	2	3	4	5	6	7	8	9	10	11	12
A	-60.3	-61.4	-61.9	-65.1	-62.6	-65.1	-62.6	-67.0	-67.4	-65.8	-65.2	-68.9
B	-65.5	-63.6	-62.4	-65.2	-63.3	-63.2	-66.8	-67.5	-65.2	-62.7	-70.3	-68.5
C	-60.8	-58.9	-56.3	-63.7	-58.7	-58.4	-61.9	-63.2	-67.1	-66.9	-69.9	-66.5
D	-55.2	-52.8	-53.4	-50.9	-53.6	-57.3	-57.1	-56.0	-56.8	-53.0	-56.4	-57.3
E	-62.8	-61.1	-63.7	-61.8	-65.1	-59.7	-67.0	-61.8	-63.2	-64.2	-66.1	-67.5
F	-50.6	-46.8	-47.9	-47.3	-46.2	-44.6	-51.3	-51.8	-49.7	-53.0	-53.7	-52.1
G	-64.6	-65.2	-57.2	-61.2	-61.2	-60.8	-66.6	-64.5	-66.0	-62.2	-69.6	-73.8
H	-67.8	-63.0	-57.9	-66.3	-64.7	-70.5	-64.0	-63.7	-65.3	-65.3	-66.2	-70.5
<u>TEMPERATURE SETPOINT:</u> 37.0				<u>CHAMBER TEMPERATURE:</u>				HIGH: 37.1		LOW: 37.1		
<u>NEGATIVE KINETICS</u>												
GRAPHICS												
Run Time = 2 MINUTES						OD Limit = 200 mOD						
NOTE: BLANK VALUES ARE NOT SUBTRACTED FROM KINETIC GRAPHS.												
	1	2	3	4	5	6	7	8	9	10	11	12
A												
B												
C												
D												
E												
F												
G												
H												

Figure 2.1: Kinetics (Negative) Graphics Printout (THERMOmax Example)

Computer Control

Molecular Devices has developed computer-based software programs called SOFTmax and SOFTmax PRO which are used to control the MAXline Microplate Reader and to perform sophisticated data handling and analysis. The software programs are easy to use, powerful and flexible. Both SOFTmax and SOFTmax PRO can be used to control the MAXline Microplate Reader from an IBM-compatible computer using either Microsoft Windows, version 3.1 or greater, or Windows 95, or from a Macintosh computer (operating system 7.1 or greater).

Separate manuals describe the capabilities of SOFTmax and SOFTmax PRO and their use in controlling the MAXline Microplate Reader and analyzing and reporting data.

NOTE: If you intend to use any software for clinical evaluations, you must ensure that it has been validated for proper performance prior to use.

Chapter 3 Installation

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Setting Up for Stand-Alone Use	3-4
Setting Up for Computer Control	3-5
Computer and Printer Cable Connections	3-5

Installation Cautions and Warnings

- ⚠ **WARNING:** Always turn the instrument off and remove the power cord from the back prior to any maintenance or installation operation.
- ⚠ **WARNING:** Never perform any operation on the instrument in an environment where liquids or potentially damaging gases are present.
- ⚠ **WARNING:** Use only the tools described to perform the steps defined in the instructions.
- ⚠ **CAUTION:** Never touch any of the fiber optic cables or their housing, manifold, or rotor connections. These fibers are extremely delicate and critical to the performance of the instrument.
- ⚠ **CAUTION:** Do not touch or loosen any screws or parts other than those specifically designated in the instructions. Doing so could cause misalignment and possibly void the warranty.
- ⚠ **CAUTION:** Never touch the surfaces of the interference filters or optical lenses.

Unpacking

Each MAXline Microplate Reader is packed in a specially designed carton. **Please retain the carton and the packing materials.** If the unit is returned for repair, you must use the original packing materials and carton for shipping. If the carton has been damaged in transit, it is particularly important that you retain it for inspection by the carrier in case there has also been any damage to the instrument.

After examining the carton, place it on a flat surface in the upright position. Open the top of the box and lift the MAXline Microplate Reader, with the packing materials around the ends, up and out of the shipping box. Remove the packing material from both ends of the instrument. The items listed in the following section are included in the packing carton. Make sure these items are all present before proceeding.

Instrument Package

- MAXline Microplate Reader
 - The THERMOmax comes with five interference filters (340, 405, 450, 490, 650 nm) already installed
 - The Emax and Vmax each come with four interference filters (405, 450, 490, 650 nm) already installed
- Power cord (6 feet)
- User's Manual
- Extra fuse
- (THERMOmax only) Extra lamp
- Two packets of Blank Pattern Templates (10 each)
- (THERMOmax only) Drawer subplate and removal tool
- Warranty Registration Card (inside the back cover of this User's Manual). This card must be filled out and returned within ten days of receipt of the MAXline Microplate Reader to ensure validation of the warranty.

Setting Up for Stand- Alone Use

- 1) Place the MAXline Microplate Reader on a level surface away from direct sunlight, dust, drafts, vibration, and moisture.
- 2) If you have received optical filters in addition to the filters already installed in the instrument, refer to “Installing Optional Optical Filters” on page 7-4 for detailed instructions regarding installation of the optical filters.

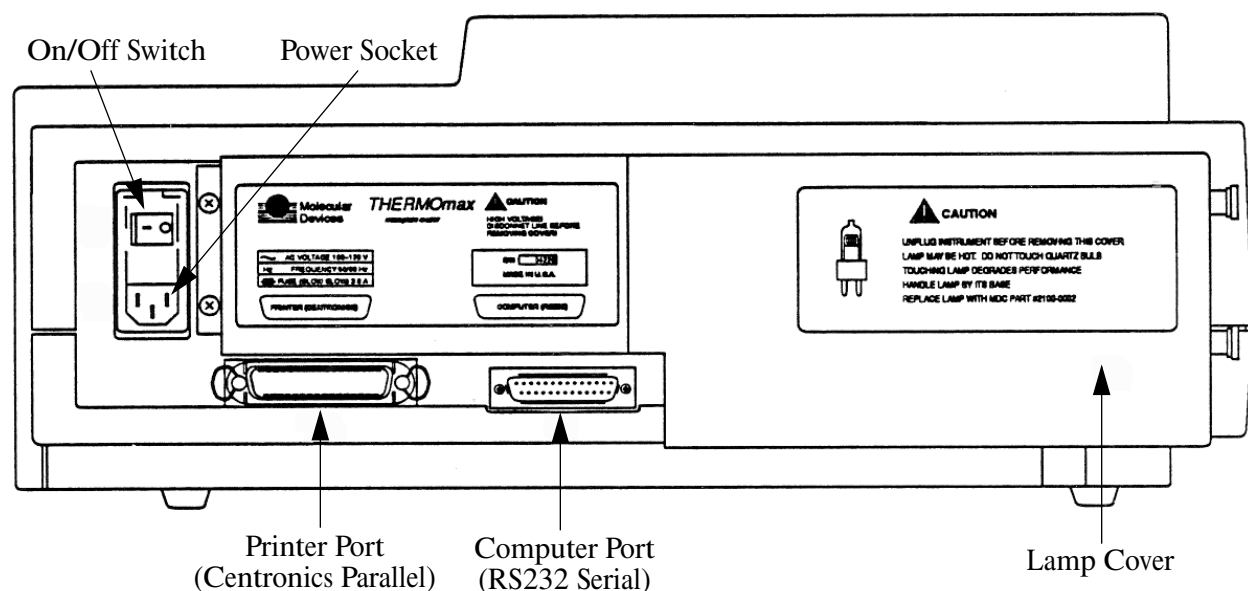


Figure 3.1: View of Rear Panel (THERMOmax Shown).

- 3) Turn the instrument around so that the rear panel faces you as shown in Figure 3.1.
- 4) Locate the printer port (Centronics parallel) for printer connection on the rear panel. Connect the appropriate end of the printer cable here and the other end to the printer.
- 5) Load paper in the printer according to the manufacturer's instructions and connect the printer to the power outlet.
- 6) Insert the power line into the power socket at the rear of the MAXline Microplate Reader and connect it to a grounded power outlet of the appropriate voltage as indicated on the rear panel of your instrument.
- 7) Turn the instrument around again so that the control panel now faces toward you. Be sure no cables run underneath the instrument. Leave at least three inches between the back of the instrument and the nearest object(s) or surface to ensure proper ventilation and cooling of the instrument.

Operating instructions and a description of the operating controls are in Sections 4 and 5 of this User's Manual.

Tmax

- 8) (For THERMOmax only) Locate the microplate drawer subplate. It is a black metal plate with 96 holes corresponding to the microplate wells with notches on two sides. Open the microplate drawer of the THERMOmax. The drawer will automatically open when the instrument is turned on. Place the subplate in the microplate drawer matching the notches with the microplate drawer springs. Press the subplate into the drawer. To remove the subplate, refer to “Removing the Drawer Subplate” on page 7-20.

Setting Up for Computer Control

Each of the MAXline Microplate Readers comes with an RS232 port for connection to a controlling device such as a computer (see Figure 3.1). If you have purchased SOFTmax or SOFTmax PRO software for the MAXline Microplate Reader, be sure to read the User's Manual which accompanies that software.

Computer and Printer Cable Connections

This section describes the cable connections suitable for three different configurations of the MAXline Microplate Reader. An illustration of the positioning and cable connections for all the components in each of these three configurations, and a description of the connecting ends of each required cable is provided.

The descriptions of cable end connectors are for the end of the cables that are attached to the microplate reader. Computer and printer connection ports are not standardized.

CAUTION: All cables must be shielded and wired straight through. All connectors must be molded and NOT have a removable shell.

The cable ports on the rear panel of the MAXline Microplate Reader are standardized and will always require a 25-pin male RS232 serial cable connector for the computer and a 36-pin male Centronics parallel cable connector for the printer.

NOTE: Printers used in stand-alone mode must be Epson Graphics Mode compatible. This may require changing the dip switch or pin settings on the printer. Please check the manual for your printer to assess compatibility based on this criterion.

Stand-Alone Configuration

In the stand-alone configuration, the MAXline Microplate Reader is connected only to a printer as shown in Figure 3.2. The Centronics parallel cable required has a 36-pin male connector at the instrument end and at the printer end.

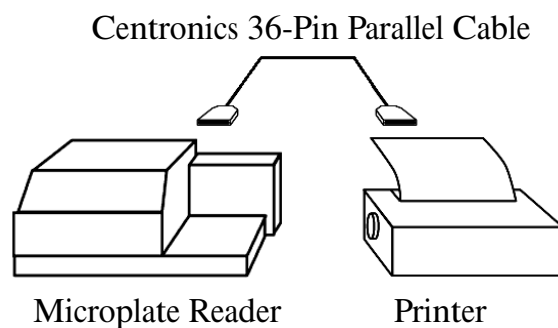


Figure 3.2: Connecting the MAXline Microplate Reader to a Printer

Connection to a Computer and a Printer

In this configuration, as shown in Figure 3.3, the MAXline Microplate Reader and a printer are both connected to a computer and not to each other. Two cables are required. Typical connections are shown in Figure 3.3, below, for both a PC and Macintosh computer.

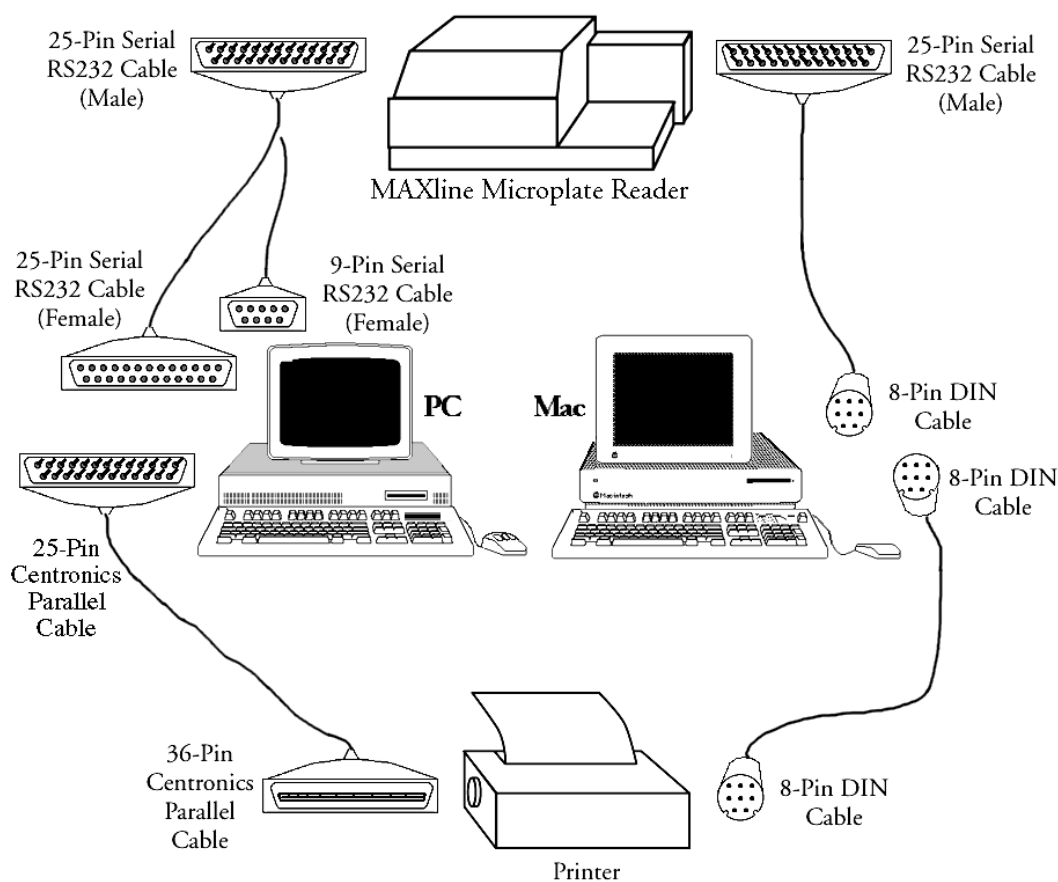


Figure 3.3: Connecting the MAXline Microplate Reader to a Computer and a Printer

Connections for a PC

The computer-to-instrument RS232 serial cable required has a 25-pin male connector at the instrument end and a 9-pin female or a 25-pin female connector at the computer end (depending on the type of computer). The computer-to-printer Centronics parallel cable has a 25-pin male connector at the computer end and a 36-pin male connector at the printer end (Molecular Devices Part Number 9000-0005). In this configuration, software running on the computer drives the MAXline Microplate Reader and a printer. The MAXline Microplate Reader is not connected directly to the printer.

The controlling computer may be running SOFTmax or SOFTmax PRO for Windows, or other software (such as a terminal emulation package) to control the microplate reader.

25-Pin to 25-Pin Cable Pin Routings

When connecting to a 25-pin COM port, the following pin routings are required. Only the pin numbers indicated are active.

Table 3.1: 25-Pin Cable Pin Routings

25-Pin Male Connector (Reader End)	25-Pin Female Connector (Computer End)
3	3
2	2
5	5
4	4
7	7
1	1

To obtain a 25-pin to 25-pin cable with the required pin routings, order Molecular Devices Part Number 9000-0006.

25-Pin to 9-Pin Cable Pin Routings

When connecting to a 9-pin COM port, the following pin routings are required. Only the pin numbers indicated are active.

Table 3.2: 25-Pin to 9-pin Cable Pin Routings

25-Pin Male Connector (Reader End)	25-Pin Female Connector (Computer End)
3	2
2	3
5	8
4	7
7	5

To obtain a 25-pin to 9-pin cable with the required pin routings, order Molecular Devices Part Number 9000-0007.

Connections for a Macintosh

The computer-to-instrument RS232 serial cable required has a 25-pin male connector at the instrument end and an 8-pin DIN connector at the computer end. The computer-to-printer Centronics parallel cable has an 8-pin DIN connector at the computer end and an 8-pin DIN connector at the printer end. In this configuration, software running on the computer drives the MAXline Microplate Reader and a printer. The MAXline Microplate Reader is not connected directly to the printer.

The controlling computer may be running SOFTmax for Macintosh, SOFTmax PRO for Macintosh, or other software (such as a terminal emulation package) to control the microplate reader.

25-Pin to 8-Pin Cable Pin Routings

When connecting to an 8-pin serial port of a Macintosh, the following pin routings are required. Only the pin numbers indicated are active.

Table 3.3: 25-Pin to 8-Pin DIN Cable Pin Routings

25-Pin Male Connector (Reader End)	8-Pin Din Male Connector (Computer End)
20	1
5	2
2	3
7	4
3	5
No Connection	6
No Connection	7
No Connection	8
Metal Shell	Metal Shell

To obtain a 25-pin to 8-pin DIN cable with the required pin routings, order Molecular Devices Part Number 9000-0077.

Chapter 4 Operating Controls

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General

This section describes the location and action of the operating controls of the MAXline Microplate Reader. For information regarding when or why to use certain controls, see Chapter 5, "Operating Instructions."

Front Panel Control

The operating keys located on the control panel are shown in Figures 4.1 through 4.3 for the Emax, Vmax, and THERMOmax, respectively. The operating keys are pressure-sensitive membrane contact points. They are user friendly, touch sensitive, and long-lasting. When you touch a control key, the MAXline Microplate Reader will respond immediately by beginning the desired action and a soft beep will let you know the command has been registered.

NOTE: When using Molecular Devices' SOFTmax or SOFTmax PRO software from an external microcomputer, the REMOTE status indicator LED (light-emitting diode) will be illuminated during the time the computer is controlling the instrument. The operating keys will not respond while the REMOTE status indicator LED is illuminated. When the computer has finished collecting data, the REMOTE status indicator will be turned off and the control panel may be used as in the stand-alone mode.

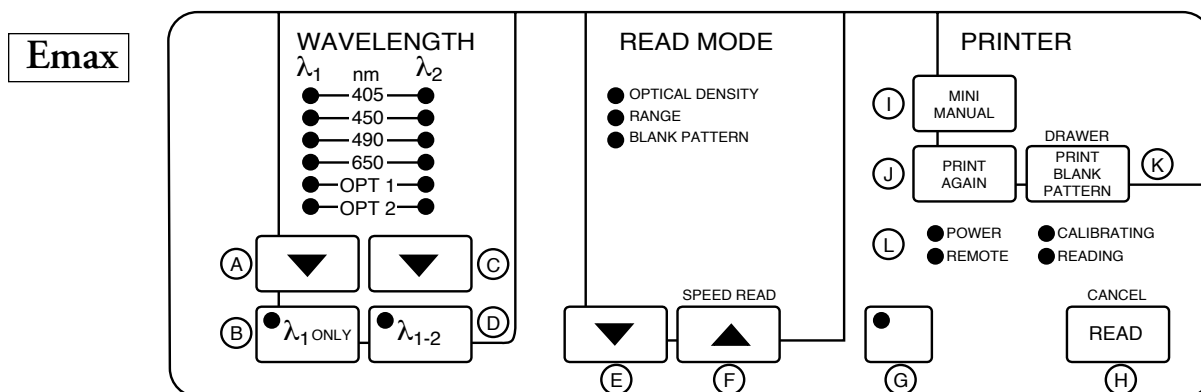


Figure 4.1: Emax Front Control Panel

- A: Sample Wavelength Selection Key
- B: Single Wavelength Key
- C: Reference Wavelength Selection Key
- D: Dual Wavelength Key
- E: Read Mode Down Arrow Selection Key
- F: Read Mode Up Arrow Selection (Speed Read) Key
- G: Shift Key (Green)
- H: Read (Cancel) Key
- I: Mini Manual Key
- J: Print Again Key
- K: Print Blank Pattern (Drawer) Key
- L: Status Indicator LEDs

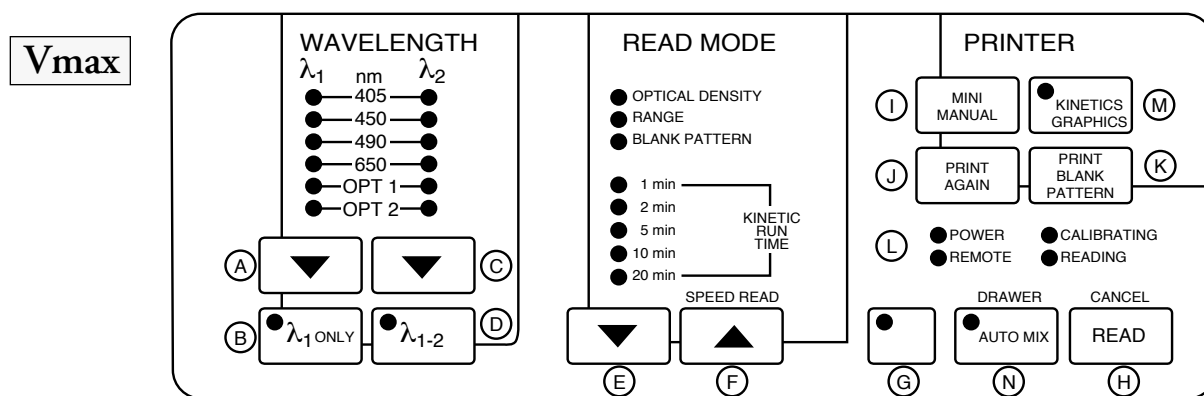


Figure 4.2: Vmax Front Control Panel

- A: Sample Wavelength Selection Key
- B: Single Wavelength Key
- C: Reference Wavelength Selection Key
- D: Dual Wavelength Key
- E: Read Mode Down Arrow Selection Key
- F: Read Mode Up Arrow Selection (Speed Read) Key
- G: Shift Key (Blue)
- H: Read (Cancel) Key
- I: Mini Manual Key
- J: Print Again Key
- K: Print Blank Pattern Key
- L: Status Indicator LEDs
- M: Kinetics Graphics Key
- N: AUTOMix (Drawer) Key

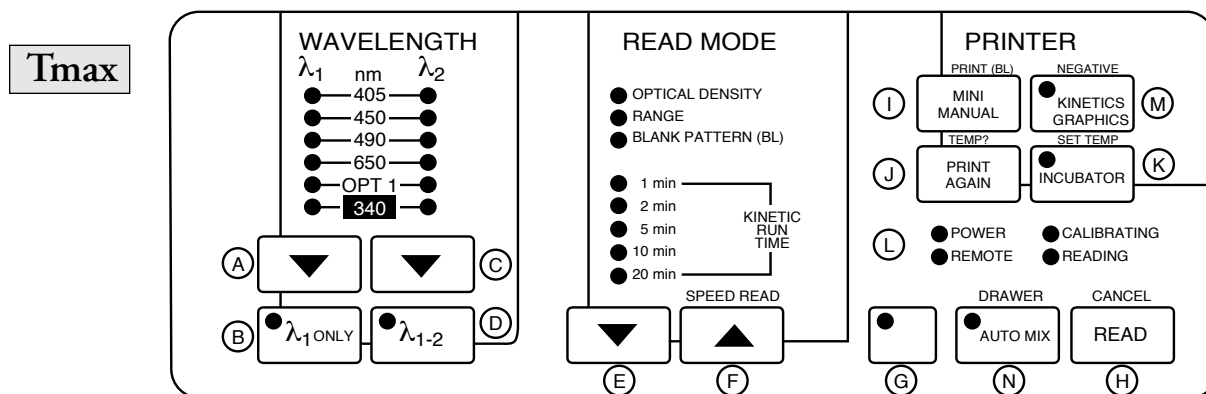


Figure 4.3: THERMOmax Front Control Panel

- A: Sample Wavelength Selection Key
- B: Single Wavelength Key
- C: Reference Wavelength Selection Key
- D: Dual Wavelength Key
- E: Read Mode Down Arrow Selection Key
- F: Read Mode Up Arrow Selection (Speed Read) Key
- G: Shift Key (Red)
- H: Read (Cancel) Key
- I: Mini Manual (Print Blank Pattern) Key
- J: Print Again (Temperature Query) Key
- K: Status Indicator LEDs
- L: Incubator (Set Temperature) Key
- M: Kinetics Graphics (Negative) Key
- N: AUTOMix (Drawer) Key

Wavelength Selection

This panel contains all controls relating to wavelength selection.

- A) **Sample Wavelength Selection** Key
This key scrolls downward through the list of available sample wavelengths (λ_1) and returns (wraps around) to the top.
- B) **λ_1 ONLY** Single Wavelength Key
This key selects the single wavelength mode of operation
- C) Reference Wavelength Selection Key
This key scrolls downward through the list of available sample wavelengths (λ_2) and returns (wraps around) to the top. It is only activated when the dual wavelength mode is selected.
- D) **λ_1 2** Dual Wavelength Key
This key selects the dual wavelength mode of operation.

Read Mode Selection

This panel contains all controls relating to read mode selections.

- E) Read Mode Down Arrow [▼] Selection Key
This key selects the read mode by scrolling downward through the listed options.
- F) Read Mode Up Arrow [▲] Selection (SPEED READ) Key
This key selects the read mode by scrolling upward through the listed options. The secondary function of this key is SPEED READ which allows consecutive read cycles with no 5 second pre-read plate calibration. Any change in a reading parameter (e.g., wavelength) will cancel SPEED READ.

Operating Controls and Secondary Functions

- G) [SHIFT] Key (Emax=Green; Vmax=Blue; THERMOmax=Red)
The [SHIFT] key activates all superscript or secondary functions printed above the operating keys. These functions include:
 - 1) The CANCEL function invoked through the [SHIFT] key and the [READ] key;
 - 2) The open/close DRAWER function invoked through
 - a) [THERMOmax/Vmax] the [SHIFT] key and the [AUTOMix] key, or
 - b) [Emax] the [SHIFT] and [PRINT BLANK PATTERN] key;
 - 3) The SPEED READ function invoked through the [SHIFT] key and the READ MODE UP ARROW [▲] key;
 - 4) The TEMPERATURE QUERY function invoked through the [SHIFT] key and the [PRINT AGAIN] key;
 - 5) The SET TEMPERATURE function invoked through the [SHIFT] key and the [INCUBATOR] key;
 - 6) The PRINT BLANK PATTERN function invoked through the [SHIFT] key and the [MINI MANUAL] key;
 - 7) and the NEGATIVE KINETICS function invoked through the [SHIFT] key and the [KINETICS GRAPHICS] key.

By touching the [SHIFT] key followed by any of the specific keys mentioned, the secondary function listed above the key in colored superscript is invoked.

- H) [READ] (CANCEL) Key
This key initiates a calibration cycle, closes the drawer, and reads the loaded microplate according to the selected Read Mode. The results are then automatically printed out and the drawer opens. Secondary function of this key is to CANCEL any function in process.

Tmax

- | | |
|--------------|--|
| Tmax
Vmax | K) [INCUBATOR] (SET TEMPERATURE) Key |
| | The thermal regulation of the microplate chamber is activated by this key. The LED on this key will be illuminated when the thermal regulation is operative. When the instrument is turned on, the default temperature set point of the incubator is 37.0°C. The secondary function of this key is the SET TEMPERATURE function. This command will open the drawer to allow you to place a blank pattern template in the drawer. The blank pattern template can be marked to encode a new temperature set point for the incubator. The new temperature set point will be valid until the instrument is turned off or a new set temperature is assigned. (See Set Temperature Selection, page 5-6). |
| | N) [AUTOMix] (DRAWER) Key |
| | This key permits selection of automatic mixing of the well contents in all 96 wells of the microplate before each read cycle. Secondary function of this key is to open/close the drawer. |

Print Selection

This panel contains all controls relating to printer output selections.

- | | |
|------|--|
| Tmax | I) [MINI MANUAL] (PRINT BL PATTERN) Key |
| | This key activates printing of a one page summary of the operating procedures. The Mini Manual is printed in full in Chapter 6, "Operator's Mini Manual." The secondary function of this key is the PRINT BLANK PATTERN function. This command prints a display of the wells in the current blank set. |
| | J) [PRINT AGAIN] (TEMPERATURE QUERY) Key |
| | This key prints the last data set again. This function is particularly helpful if you forget to switch on or connect the printer. With Vmax or THERMOmax instruments, you can print the kinetics graphics after a kinetic read by touching the [KINETICS GRAPHICS] key and the [PRINT AGAIN] key. With the THERMOmax, this key performs a TEMPERATURE QUERY as a secondary function. This command prints the current chamber temperature and the temperature set point of the THERMOmax microplate reader. |
| | M) [KINETICS GRAPHICS] (NEGATIVE) Key |
| | This key activates the automatic printout of an 8-x-12 microplate matrix of the kinetic data set. The LED on the key will be illuminated when the key is activated. The optical density versus time plots for all 96 wells will be sent to the printer in addition to the calculated rates at the end of a kinetic read. You can reprint the kinetic plots by touching the [PRINT AGAIN] key while the LED of this key is illuminated. For THERMOmax only, the secondary function of this key is to print out negative kinetic plots. |

Status Indicators (LEDs)

- L1) Power
The POWER indicator lights when the power has been turned on.
- L2) Remote
This indicator is illuminated when the instrument is operating under computer control. The control panel keys are deactivated and will not operate when the MAXline Microplate Reader is receiving commands from a computer or sending commands to a computer. The indicator will blink on and off when computer control is established and flicker periodically. It will be solid red when a command, such as Read Plate, is issued from the SOFTmax or SOFTmax PRO software.
- L3) Calibrating
This indicator is illuminated during the automatic calibration cycle, before the instrument reads the microplate.
- L4) Reading
The READING indicator lights while the instrument is reading a microplate. During kinetics readings (Vmax/THERMOmax), this indicator remains illuminated for the entire kinetic read time selected.

Default Override Controls

NOTE: The following override controls apply **only** to stand-alone instrument operation. *Use of these controls is not required when using SOFTmax or SOFTmax PRO to control the Series 1 instrument.*

- DO1) Extended Optical Density Range
Normally the MAXline Microplate Reader defaults to a maximum OD range of 3.00. If you want to extend the OD range (to 4.00 for Emax or Vmax, or to 4.200 for THERMOmax), switch the instrument off, then touch and hold the [READ] key down while you switch the instrument back on. Hold the key down for approximately two seconds. The maximum OD range will now remain at the extended setting until the instrument is switched off.
- DO2) 2400 Baud RS232 Communications
Normally the MAXline Microplate Reader defaults to 9600 baud RS232 communications. To set the baud rate to 2400, switch the instrument off, then touch and hold the Sample Wavelength Selection [▼] key down while you switch the instrument back on. Hold the key down for approximately two seconds. The RS232 communications baud rate will remain at 2400 until the instrument is switched off.
- DO3) Instrument Output to the RS232 Port
Normally the MAXline Microplate Reader defaults

to sending output to the printer. To send output to the RS232 port, switch the instrument off, then touch and hold the **PRINT AGAIN** key down while you switch the instrument back on. Hold the key down for approximately two seconds. All output (except kinetics graphics) will now be sent to the RS232 port until the instrument is switched off.



- DO4) Single AUTOmix for Liquid Phase Kinetics
- Normally the MAXline Microplate Reader defaults to shaking the plate drawer before each kinetics reading when AUTOmix is selected. To have a single mixing at the beginning of the kinetics run but no additional mixing between readings, switch the instrument off, then touch and hold the **AUTOmix** key down while you switch the instrument back on. Hold the key down for approximately two seconds. The single AUTOmix feature **FOR KINETICS RUNS ONLY** will remain in effect until the instrument is switched off.

NOTE: This feature does not affect the AUTOmix function for endpoint readings.

Chapter 5 Operating Instructions

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Preparation

- 1) Switch the MAXline Microplate Reader on by setting the power rocker switch, located at the rear of the instrument on the right, to the on position (see Figure 3.1 on page 3-4). All of the LEDs on the control panel will turn on and then off in a self-diagnostic sequence. The power indicator LED and the default settings will remain on.
- 2) Switch the printer on according to the printer manufacturer's instructions.
- 3) Allow the MAXline Microplate Reader to warm up for at least 30 seconds after power up.
- 4) Allow the microplate chamber to warm up for 30 minutes after the incubator is turned on. For line voltage lower than normal (<120 or <220 VAC), a longer warm-up time may be required.

Tmax

Wavelength Selection (Stand-Alone Mode)

The following descriptions apply to wavelength selection made when using the MAXline Microplate Reader *in stand-alone mode only*. When using either SOFTmax or SOFTmax PRO software to control the instrument, wavelength selection is determined through the software program and front panel settings are not used.

Single Wavelength Mode ($\lambda 1$ Only) Selection

Select the single wavelength mode ($\lambda 1$ only) by touching the Single Wavelength [▼] key, located on the WAVELENGTH panel. The LED indicator on the key will be illuminated when the single wavelength capability has been activated.

Dual Wavelength Mode ($\lambda 1-2$) Selection

Select the dual wavelength mode ($\lambda 1-2$) by touching the Dual Wavelength [▼] key. The LED indicator on the key will be illuminated when the dual wavelength capability is activated. Dual wavelength selection is only possible for endpoint readings (optical density and range).

Wavelength Selection

The illuminated LED(s) on the WAVELENGTH panel show(s) the currently selected sample ($\lambda 1$) and reference ($\lambda 2$) wavelength(s). Change the wavelength(s) by touching the wavelength selection arrow key(s) to move the LED indicator to the appropriate wavelength(s). The indicator function will wrap around to the top to accommodate each of the wavelength selections represented. If you select the same wavelength for your sample and reference the MAXline Microplate Reader will override this and a single wavelength reading at the wavelength selected will result.

Blank Pattern Selection

Selecting BLANK PATTERN (BL) on the READ MODE panel allows you to instruct the instrument which wells should be treated as “blanks” or, taken together, as the “blank set.” The MAXline Microplate Reader retains the blank pattern information in memory until the power is switched off, or until new blank set location instructions are given. When using SOFTmax or SOFTmax PRO software for the MAXline Microplate Readers, blank patterns may be set and/or altered through the host computer.

Each time a microplate is read, either in one of the endpoint modes or the kinetic mode (Vmax/THERMOmax), the average OD or milli-OD/minute reading of the wells in the current blank set will be computed. This mean value is then subtracted from all the readings, including those of the individual members of the blank set. For wells which are members of the blank set, the character “#” will replace the decimal point or, in the range mode, it will precede the reported single or double integer value. This feature allows subtraction of values of negative controls, substrate blanks, or other special calibrators.

Blank set location information is supplied to the instrument by use of a blank pattern template. Two packets of blank pattern templates are provided with the MAXline Microplate Reader. Take one template by the center tab, as shown in Illustration 6, and mark wells on the template you want in the “blank set” with a common lab marker (black works best). Templates can also be constructed from microplates or from microplate lids which have well locations indicated. You may construct blank set patterns by filling selected microplate wells with optically dense solution, or by blackening microplate lids at selected sites with a glassware marker pen. It is only necessary that the blank set wells on the template have an OD >0.500.

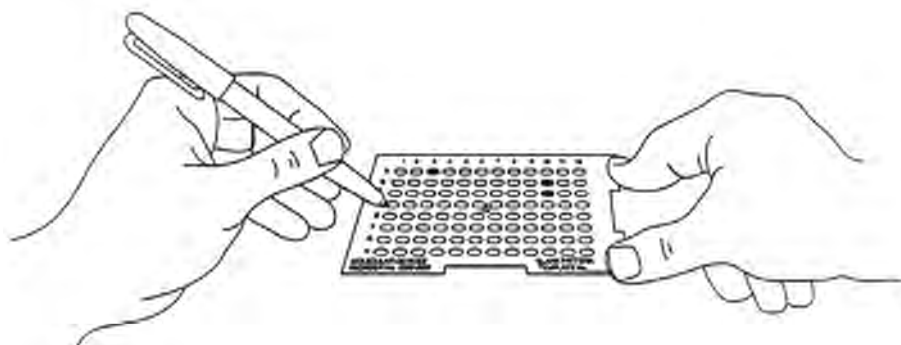


Figure 5.1: *Creating a Blank Set Template*

When you have prepared the blank set pattern, select BLANK PATTERN (BL) on the READ MODE panel.

Tmax

NOTE: For the THERMOmax only: if the incubator is on and the drawer is closed, open the drawer by using the **[SHIFT]** key and **[AUTOmix]** key—the drawer will remain open for 10 seconds. A beeping sound will alert you two seconds before the drawer automatically closes.

Load the template in the drawer (match template well A1 with drawer position A1), making sure it is flush on all sides and lies flat. You may touch the **READ** key any time after the blank pattern template is properly positioned in the drawer.

After reading the template, the instrument will respond by printing a display of the well locations selected, represented by the character “#”, as members of the blank set. All other wells will be indicated by the character “.” (a single dot; see Illustration 8, page 5-16). At any other time, the PRINT BLANK PATTERN function activated by touching the **SHIFT** key and the **MINI MANUAL** key, will print the existing blank set pattern. To change (or clear) the blank set pattern, repeat the steps above using a new blank pattern template. The blank set pattern will also be cleared when you turn the MAXline Microplate Reader off.

After you have set your blank pattern, remember to change your read mode selection to the desired read mode before reading sample plates.

Set Temperature Selection

Imax

The THERMOmax has been designed to regulate the temperature of the microplate chamber from 4°C above ambient to 42.0°C. Upon power up and selection of temperature regulation (pressing the **INCUBATOR** key), the THERMOmax temperature set point will default to 37.0°C. If you select to use a temperature other than 37.0°C, the temperature set point can be reset.

To reset the temperature set point, use the blank pattern template which is provided with your instrument. (Alternatively you may construct a template by using a microplate with an optically dense solution or a microplate lid which has the well positions clearly marked.) Row A, row B, and row C of the template correspond to the tens, ones, and tenths of the temperature set point, respectively. The columns numbered 1–9 correspond to the numbers of the desired temperature set point. An empty row is assigned as zero (0).

Darken the appropriate wells of the template or microplate lid, or fill the appropriate wells of the microplate with an optically dense solution having an OD ≥ 0.500 . For example, to change the temperature set point to 31.5°C, pick up the blank pattern template by the center tab. Fill in the well in row A, column 3 with a common laboratory marker (black works best). Then fill in the wells in row B, column 1 and row C, column 5.

The SET TEMPERATURE function, activated by touching the **SHIFT** key and the **INCUBATOR** key, will open the drawer to allow you to place the blank pattern template into the drawer. The pattern will be read and interpreted as the new temperature set point. The THERMOmax will confirm the new temperature set point by printing the value. If the entry was invalid, the temperature set point will not be changed. The printer will display the error message as well as the current temperature set point.

Temperature Query

Tmax The TEMPERATURE QUERY function (TEMP?), activated by touching the **[SHIFT]** key and the **[PRINT AGAIN]** key, will send the current microplate chamber temperature and the temperature set point to the printer. The microplate chamber temperature is also printed with the data for optical density, range and kinetic reading performed by the instrument.

Incubator Operation

The temperature regulation of the microplate chamber is activated by touching the **[INCUBATOR]** key. An LED located on the **[INCUBATOR]** key will begin to flash. The LED will continue to flash until the microplate chamber has reached the Temperature Set Point, $\pm 0.3^{\circ}\text{C}$. Typically, the microplate chamber will reach 37.0°C in less than 30 minutes. Low line voltage may extend this time. The LED will flash slowly to indicate that the temperature of the microplate chamber has not reached the temperature set point. When the temperature of the microplate chamber is within 1.5°C of the set point, the LED will flash more frequently. The LED will stop flashing and remain illuminated when the temperature of the microplate chamber has reached the temperature set point. The LED will flash as a warning should the temperature of the microplate chamber ever deviate from the temperature set point.

The microplate chamber temperature will be maintained at the temperature set point until the **[INCUBATOR]** key is touched again. When the incubator is turned off, the LED will also be turned off, the drawer will open and the temperature within the microplate chamber will begin to return to ambient temperature.

NOTE: When the incubator is turned off, the temperature regulation control algorithm will be reset to a null default. Should you select to turn the incubator back on after a momentary shut down, allow about 10 minutes for the control algorithm to fully stabilize the microplate chamber temperature.

AUTOMix Function

Tmax
Vmax The AUTOMix function permits selection of automatic mixing of the contents in the microplate wells. When activated, AUTOMix mixes the well contents of all wells before each READ cycle. AUTOMix may be used in all read modes, but must be selected before beginning a reading. For endpoint readings, AUTOMix will mix the microplate for five seconds prior to the read. For kinetic readings, AUTOMix will mix the microplate for ten seconds prior to the first read and for three seconds before each reading in the kinetic run thereafter. When AUTOMix is on, the LED on the **[AUTOMix]** key will be illuminated. See also Default Override Controls (page 4-8) for additional AUTOMix options.

Use of AUTOMix is strongly recommended for ELISAs and other solid-phase, enzyme-mediated reactions to enhance accuracy.

Read Mode Selection

The illuminated LED on the READ MODE panel will show the currently selected READ MODE. Change the READ MODE by touching the READ MODE UP/DOWN ARROW [▲][▼] SELECTION keys. Your selection determines the type of measurement made when you touch the **READ** key. Choices are as follows:

Optical Density (Endpoint Mode)

This choice selects an OD measurement of all wells with a resolution of 0.001 OD. Optical density may be read in either single or dual wavelength mode, as described in Endpoint Analysis (page 2-5) and Wavelength Selection (page 5-3). For values greater than 3.000 OD in the default setting, or 4.000 or 4.200 OD in the extended range setting, the asterisk character “*” is printed. For values less than 0 (this happens if blank values are higher than sample values) the minus character “-” is printed. See Figure 5.2 for an example of this printout.

MOLECULAR DEVICES				THERMOmax MICROPLATE READER						PLATE #: 2		
ASSAY: _____								DATE: ____/____/____				
OPERATOR: _____						O.D. RANGE: 3.000		TIME: ____: ____AM/PM				
WAVELENGTH: 405 nm					AUTO MIX: OFF				CAL: ON			
<u>OPTICAL DENSITY</u>												
	1	2	3	4	5	6	7	8	9	10	11	12
A	2.405	2.430	2.459	2.432	2.448	2.407	2.386	2.409	2.419	2.384	2.423	2.399
B	2.206	2.174	2.208	2.214	2.204	2.243	2.241	2.205	2.209	2.245	2.205	2.237
C	1.925	1.939	1.915	1.965	1.953	1.947	1.971	1.938	1.953	1.948	1.938	1.940
D	1.724	1.899	1.714	1.710	1.727	1.709	1.727	1.709	1.705	1.701	1.699	1.707
E	1.519	1.498	1.479	1.490	1.471	1.494	1.486	1.473	1.477	1.472	1.460	1.491
F	1.259	1.217	1.214	1.204	1.192	1.199	1.214	1.214	1.205	1.209	1.202	1.208
G	0.972	0.963	0.967	0.957	0.957	0.967	0.961	0.957	0.963	0.955	0.957	0.946
H	0.778	0.771	0.779	0.721	0.728	0.725	0.729	0.733	0.730	0.758	0.737	0.740

1486 09

Figure 5.2: Optical Density Printout (THERMOmax Example)

Range (Endpoint Mode)

The RANGE option is selected to report the intensity of color as an integer value equal to the OD reading multiplied by ten and truncated after the decimal point. For example, the OD reading 1.592 would be represented by 15. RANGE may be used in either the single or the dual wavelength mode. Values exceeding the OD measurement range are treated in the same manner as OPTICAL DENSITY readings as explained in the preceding paragraph. See Figure 5.3.

<u>MOLECULAR DEVICES</u>				<u>THERMOmax MICROPLATE READER</u>						<u>PLATE #:</u> 1		
ASSAY: _____									DATE: ____/____/____			
OPERATOR: _____						<u>O.D. RANGE:</u> 3.000		TIME: ____: ____AM/PM				
<u>WAVELENGTH:</u> 405 nm					<u>AUTO MIX:</u> OFF				<u>CAL:</u> ON			
<u>RANGE DISPLAY</u>												
	1	2	3	4	5	6	7	8	9	10	11	12
A	24	23	23	24	24	24	24	23	24	24	24	24
B	22	21	22	22	21	22	22	22	22	22	22	22
C	19	19	18	19	19	19	18	19	19	19	19	19
D	17	16	17	17	17	17	17	17	16	17	17	17
E	15	14	14	14	14	15	14	14	14	14	15	14
F	12	12	12	12	11	11	12	12	12	12	11	12
G	9	9	9	8	9	9	9	8	9	9	9	9
H	7	7	7	7	7	7	6	7	7	7	7	7

1486 10

Figure 5.3: Range Printout (THERMOmax Example)

Vmax
Tmax

Kinetic Run Time

Stand-Alone Mode

There are five options for total KINETIC RUN TIME in stand-alone mode. The total run time of a kinetic reading can be set to 1, 2, 5, 10 or 20 minutes, using the UP/DOWN ARROW [▲][▼] keys for READ MODE selection in the KINETIC RUN TIME bracket. Intervals between READ cycles in the KINETIC READ MODE change over time. Please also note that the intervals between READ cycles in the KINETIC READ MODE change if the AUTOMix function is activated (see Table 5.1 on page 5-9).

Using SOFTmax or SOFTmax PRO

When the MAXline Microplate Reader is controlled using either SOFTmax or SOFTmax PRO, KINETIC RUN TIME can be set up to 24 or 99 hours, respectively. In addition, the read interval can be defined by the user as desired.

Table 5.1: Kinetics Read Intervals With and Without AUTOmix

Vmax	Tmax	Period of Kinetic Read		AUTOmix Off		AUTOmix On	
		From Minute:	To Minute:	Time Between Readings (seconds)	Total # of Readings Taken by End of Period	Time Between Readings (seconds)	Total # of Readings Taken by End of Period
		0	1	5	13	8	8
		1	2	5	25	8	15
		2	5	12	40	17	25
		5	10	30	50	21	40
		10	20	60	60	30	60

Reading a Sample Microplate

NOTE: The THERMOmax has two operating modes that will affect microplate drawer operation. When the incubator is off, the microplate drawer will remain open at power up and after a read. When the incubator is on, the microplate drawer will automatically close as an assist in control of the microplate chamber temperature. The drawer will automatically open when the **[READ]** key or the SET TEMPERATURE function is initiated (by pressing **[SHIFT]** and **[INCUBATOR]**). The drawer can also be opened by using the DRAWER function, activated by touching the **[SHIFT]** key and **[AUTOmix]** key. In all cases the drawer will remain open for 10 seconds. A beeping sound will alert you 2 seconds before the drawer automatically closes. Within this 10 seconds, a microplate (or a blank pattern template) can be loaded into the open drawer.

Load a microplate (or a blank pattern template) into the open drawer, matching well position A1 with drawer position A1. Make sure the microplate is flush on all sides and lies flat.

Read the microplate by touching the **[READ]** key. The instrument will automatically calibrate for five seconds (or ten seconds if dual wavelength has been selected), print a header for the reading through the printer, then close the

drawer and read the microplate according to the selected READ MODE. While calibrating, the CALIBRATING status indicator (LED) will be illuminated. While reading, the READING status indicator (LED) will be illuminated. After reading, the results are printed out immediately and the drawer will open for the removal of the microplate.

Tmax

NOTE: With the THERMOmax, if the incubator is on, the drawer will automatically close after 10 seconds. If you return to the THERMOmax and find the drawer closed after the microplate has been read, the drawer can be opened with the **[DRAWER]** key. After the drawer reopens, you may take the microplate out and insert another for reading.

For endpoint readings, you do not have to wait for the printer to finish printing before starting your next microplate. Due to the excellent drift management of the electronics on board the MAXline Microplate Reader, it is possible to override the calibration cycle after it has been set a first time in any given setting by using the SPEED READ function. SPEED READ uses the calibration data from the first reading on air while monitoring the lamp intensity for all sequential endpoint readings until a reading parameter is changed (e.g., wavelength).

Tmax
Vmax

If you are reading the microplate in the KINETIC READ MODE, you may wish to obtain the KINETICS GRAPHICS printout by activating the **[KINETICS GRAPHICS]** key. If this is done prior to a kinetics read, the graphics will be included with the printout. If you did not activate the **[KINETICS GRAPHICS]** key prior to the read but desire the graphics printout, it may be obtained by activating the **[KINETICS GRAPHICS]** key and then touching the **[PRINT AGAIN]** key. A full printout, kinetic rate values and graphics, will be produced.

If you are using a THERMOmax and want to calculate negative-going optical density rates and see negative kinetics graphics, the NEGATIVE KINETICS GRAPHICS function must be invoked using the SHIFT key and the **[KINETICS GRAPHICS]** key. You may also invoke this after a reading using the **[PRINT AGAIN]** function as explained above.

Vmax

⚠ CAUTION: After a kinetics read, the graphics printout is only obtainable PRIOR TO READING ANOTHER MICROPLATE OR SWITCHING THE INSTRUMENT OFF. While kinetics readings are being printed, another reading may not be commenced.

NOTE: If you have a blank set, the blank value will be subtracted from rate values but not from the Kinetics Graphics display. The purpose of the Kinetics Graphics display is to allow you to verify linearity for all wells (including blanks).

☣ BIOHAZARD: **⚠ CAUTION:** If you are reading microplates that may have fluid on the underside of the microplate, you must damp dry the underside using a dry paper towel or equivalent prior to putting the microplate in the drawer. Alternatively, place a clear mylar sheet

(such as a Molecular Devices Blank Pattern Template) underneath the microplate when inserting it in the drawer.

If you are using the THERMOmax and reading filter-bottom microplates where fluid may drip off the filter membrane, you must remove the drawer subplate (see “Removing the Drawer Subplate” on page 7-20) and place a clear mylar sheet under the microplate (such as a Molecular Devices Blank Pattern Template) underneath the microplate when inserting it in the drawer.

These precautions are necessary to prevent fluid from dripping from the microplate when it is in the reading chamber onto any lenses and to minimize potential biohazard exposure to other users of the MAXline Microplate Reader.

Printout Options

In addition to the automatic printing of results each time a microplate is read, as shown in Figures 5.2 and 5.3, additional printout options are available.

Mini Manual

A one-page summary of operating procedures for the MAXline Microplate Reader may be printed by touching the **MINI MANUAL** key (see Chapter 6).

Print Again

Print the last data set again by touching the **PRINT AGAIN** key. This capability is particularly helpful if you forgot to connect or switch on your printer or want to obtain a kinetics graphics print as described in the previous section.

T_{max}
V_{max}

MOLECULAR DEVICES THERMOmax MICROPLATE READER PLATE #: 1
 ASSAY: _____ DATE: ____/____/____
 OPERATOR: _____ O.D. RANGE: 3.000 TIME: ____: ____AM/PM
 WAVELENGTH: 405 nm AUTO MIX: OFF CAL: ON

KINETIC 2 MINUTE RUN (mOD/min)

	1	2	3	4	5	6	7	8	9	10	11	12
A	-60.3	-61.4	-61.9	-65.1	-62.6	-65.1	-62.6	-67.0	-67.4	-65.8	-65.2	-68.9
B	-65.5	-63.6	-62.4	-65.2	-63.3	-63.2	-66.8	-67.5	-65.2	-62.7	-70.3	-68.5
C	-60.8	-58.9	-56.3	-63.7	-58.7	-58.4	-61.9	-63.2	-67.1	-66.9	-69.9	-66.5
D	-55.2	-52.8	-53.4	-50.9	-53.6	-57.3	-57.1	-56.0	-56.8	-53.0	-56.4	-57.3
E	-62.8	-61.1	-63.7	-61.8	-65.1	-59.7	-67.0	-61.8	-63.2	-64.2	-66.1	-67.5
F	-50.6	-46.8	-47.9	-47.3	-46.2	-44.6	-51.3	-51.8	-49.7	-53.0	-53.7	-52.1
G	-64.6	-65.2	-57.2	-61.2	-61.2	-60.8	-66.6	-64.5	-66.0	-62.2	-69.6	-73.8
H	-67.8	-63.0	-57.9	-66.3	-64.7	-70.5	-64.0	-63.7	-65.3	-65.3	-66.2	-70.5
TEMPERATURE SETPOINT: 37.0 CHAMBER TEMPERATURE: HIGH: 37.1 LOW: 37.1												

NEGATIVE KINETICS _____
 GRAPHICS

Run Time = 2 MINUTES OD Limit = 200 mOD

NOTE: BLANK VALUES ARE NOT SUBTRACTED FROM KINETIC

	1	2	3	4	5	6	7	8	9	10	11	12
A												
B												
C												
D												
E												
F												
G												
H												

Figure 5.4: Negative Kinetics Printout with Kinetics (Negative) Graphics

Print Blank Pattern

Print the location of wells in the current blank set through the **PRINT BLANK PATTERN** key accessed by touching the **SHIFT** key and the **MINI MANUAL** key (see Figure 5.5).

MOLECULAR DEVICES

THERMOmax

MICROPLATE READER

NOTES:

BLANK PATTERN												
	1	2	3	4	5	6	7	8	9	10	11	12
A	#
B	#
C	#
D	#
E	#
F	#
G	#
H	#

Figure 5.5: Blank Pattern Printout (Example from THERMOmax)

Tmax

Temperature Query

Print the current Chamber Temperature and the Temperature Set Point by touching the **SHIFT** key and the **PRINT AGAIN** key.

Chapter 6 Operator's Mini Manual

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Content of the Mini Manual 6-3

Purpose

The Mini Manual is a facility built into the MAXline Microplate Reader in case the manual should be misplaced or if you do not have the time to read the manual. It is also helpful in laboratory settings where the instrument is being shared by a group of users.

By touching the **MINI MANUAL** key on the control panel, a one-page summary of the basic set-up and operating procedures is printed on your printer. Below is the content of the Mini Manual printout.

Content of the Mini Manual

Set up your MAXline Microplate Reader prior to the final stage of your assay as follows:

- 1) Confirm that the printer is "ON" and properly connected.
- 2) Touch the INCUBATOR key to heat the microplate chamber to the default temperature of 37°C. The LED will flash until set temperature is reached.
- 3) Print the set temperature by touching the red **SHIFT** key and the **PRINT AGAIN** key. Set temperature (from 4 degrees above ambient to 42°C) with the Blank Pattern Template marking rows ABC equal to XX.X°C. Touch the red **SHIFT** key and the **INCUBATOR** key and load the template in the drawer.
- 4) Select the WAVELENGTH(s), SINGLE ($\lambda 1$) or DUAL ($\lambda 1-2$), using the DOWN ARROW [▼] keys.
- 5) PRINT BLANK PATTERN using the red **SHIFT** key and the **MINI MANUAL** key. If correct, go to Step 8; to change, go to Step 6.
- 6) Set up a blank pattern by marking the blanking template or filling the wells of a microplate with anything which has an OD greater than 0.5 OD.
- 7) Set the READ MODE to BLANK PATTERN(BL) using the UP/DOWN ARROW keys. Touch the READ key and place the blanking template into the open drawer. This blank pattern will be used in all the following reads until a new blank pattern is set or the instrument is turned off. Blank values will be recalculated on each reading.
- 8) Select the READ MODE: OPTICAL DENSITY, RANGE or KINETIC RUN TIME by using the UP/DOWN ARROW [▲][▼] keys.
- 9) For a Kinetics Run, touch the **KINETICS GRAPHICS** key to print the positive kinetic plots or (for the THERMOmax only) touch the **SHIFT** key and then the **KINETICS GRAPHICS** key to print the negative kinetics plots. To deactivate KINETICS GRAPHICS, touch the **KINETICS GRAPHICS** key until the LED on the key is off.
- 10) Turn AUTOmix on or off by touching the **AUTOmix** key.
- 11) IF YOU ARE PERFORMING KINETIC ANALYSIS, ADD SUBSTRATE AT THIS TIME.

Tmax

Tmax

Tmax
Vmax

- 12) Touch the **[READ]** key and load your prepared microplate, being sure to match the A1 well to the A1 mark on upper left hand corner of the drawer. To CANCEL the READ, touch the **[SHIFT]** key and then the **[READ]** key.
- 13) Print your last data set by touching the **[PRINT AGAIN]** key. If your last data set was from a kinetics run, print the kinetics plots by touching the **[KINETICS GRAPHICS]** key followed by the **[PRINT AGAIN]** key. Data remains in memory until you touch the **[READ]** key.
- 14) SPECIAL MODES:
- A) SPEED READ will disable repeat plate calibrations prior to a read. Touch the **[SHIFT]** key and then the UP ARROW **[▲]** key to read a plate without a plate calibration. The MAXline Microplate Reader recalibrates after a WAVELENGTH or READ MODE change.
 - B) An EXTENDED OD range can be obtained by holding the **[READ]** key down for about 2 seconds while turning on the instrument. For the THERMOmax, extended OD range is 4.200; for Emax and Vmax, extended OD range is 4.000.
 - C) AUTOmix ONCE prior to a KINETIC RUN can be obtained by holding the **[AUTOmix]** key down for about 2 seconds while turning on the instrument.



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Warnings and Cautions

- ⚠ **BIOHAZARD:** Always wear gloves when performing any type of service, especially if it involves potential contact with spilled fluids or fluid residues of any kind.
- ⚠ **WARNING:** Always turn the instrument off and remove the power cord from the back prior to any maintenance or installation operation.
- ⚠ **WARNING:** Use only the tools described to perform the steps defined in the instructions.
- ⚠ **WARNING:** Never perform any operation on the instrument in an environment where liquids or potentially damaging gases are present.
- ⚠ **WARNING:** Risk of electrical shock, Refer servicing to qualified personnel.
- ⚠ **CAUTION:** Use of organic solvents (such as dichloromethane) may cause harm to the fiber optics in the microplate readers. Extreme caution is advised when using organic solvents. Always use a plate lid and avoid placing a plate containing these materials in the microplate reader for prolonged periods of time. Damage caused by the use of incompatible or aggressive solvents is **NOT** covered by the instrument warranty.
- ⚠ **CAUTION:** Never touch any of the fiber optic cables or their housing, manifold, or rotor connections. These fibers are extremely delicate and critical to the performance of the instrument.
- ⚠ **CAUTION:** Do not touch or loosen any screws or parts other than those specifically designated in the instructions. Doing so could cause misalignment and possibly void warranty.
- ⚠ **CAUTION:** Never touch the surfaces of the interference filters or optical lenses.

General

Keep the drawer closed when the machine is not in use. The drawer of any MAXline Microplate Reader can be opened by using the **DRAWER** function: for the THERMOmax and Vmax, press the **[SHIFT]** key and the **[AUTO-mix]** key; on the Emax, press the **[SHIFT]** key and then press the **[PRINT BLANK PATTERN]** key. Always close the drawer immediately prior to switching the instrument off.

DO NOT try to open or close the drawer manually and **DO NOT** obstruct the movement of the drawer. If there is an emergency (for example, a power failure) and a plate has to be retrieved, it is possible to open the drawer manually. Otherwise, do not interfere with the drawer mechanism.

Drawer Operation

Tmax

The THERMOmax has two operating modes that will affect how the microplate drawer operates. When the incubator is off, the microplate drawer will remain open at power up and after a read. When the incubator is on, the microplate drawer will automatically close after 10 seconds to assist in controlling the temperature of the microplate chamber—a beeping sound will alert you two seconds before the drawer automatically closes. The drawer of the THERMOmax will also open if the read is cancelled. Touch the **[SHIFT]** key and the **[READ]** key to CANCEL the read. The drawer will automatically open when you select **[READ]** or SET TEMPERATURE (by pressing the **[SHIFT]** and the **[INCUBATOR]** key).

Installing Optional Optical Filters

If you need additional optical filters not already installed on your instrument, order these directly from Molecular Devices. Our toll free number is (800) 635-5577. International calls may be placed to (408) 747-1700, or a telefacsimile sent to (408) 747-3602 or (408) 747-3601. Depending on the type of instrument you are using, standard filters having a 10-nm bandwidth can be ordered as follows:

- For THERMOmax, between 340 nm and 750 nm;
- For Emax and Vmax, between 400 nm and 750 nm.

Filters having a 1-nm bandwidth can be special ordered for any wavelength within the overall instrument parameters given above (i.e., between 340 nm and 750 nm for THERMOmax, and between 400 nm and 750 nm for Emax and Vmax). Contact Molecular Devices at one of the numbers above for more information regarding ordering a special optical filter.

When your new filter(s) has arrived, please carefully review the installation instructions before installing the filter(s).

Tools:

You will need a 3/32-inch hex wrench and a medium Phillips-head screwdriver to install your new filter(s).

I. Prepare the Microplate Reader

- 1) It is necessary that the drawer be empty and fully closed before commencing installation. If it is not, turn on the instrument, and after the drawer is completely out and any microplate has been removed, touch the **[SHIFT]** key and then the **[PRINT BLANK PATTERN]** key. This will close the drawer. When the drawer is all the way in, switch the power off so that the drawer remains in.
- 2) Unplug the power cord from the wall socket and from the rear panel of the instrument. Also, disconnect the printer or computer cable from the rear panel of the microplate reader. Make sure you have space behind the instrument approximately equal to the front to back width of the instrument.

- 3) Lay out a soft cloth in the space behind the instrument. Gently lift the instrument upward and turn it over onto the soft cloth so it is lying upside-down on the top casing as shown in Figure 7.1.

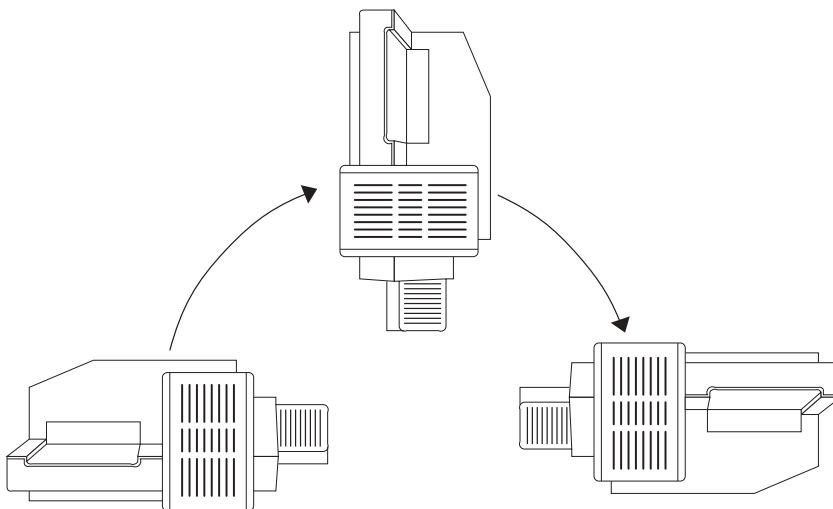


Figure 7.1: Turning the MAXline Microplate Reader Over (THERMOmax Shown)

- 4) Locate the seven silver topped screws as shown in Figure 7.2. Using a Phillips screwdriver, remove these seven screws from their slots on the bottom of the instrument. **DO NOT LOOSEN OR REMOVE ANY BLACK TOPPED SCREWS.** Note that two of the screws (5 and 6) are shorter than the other five. Put all seven screws in a secure location.

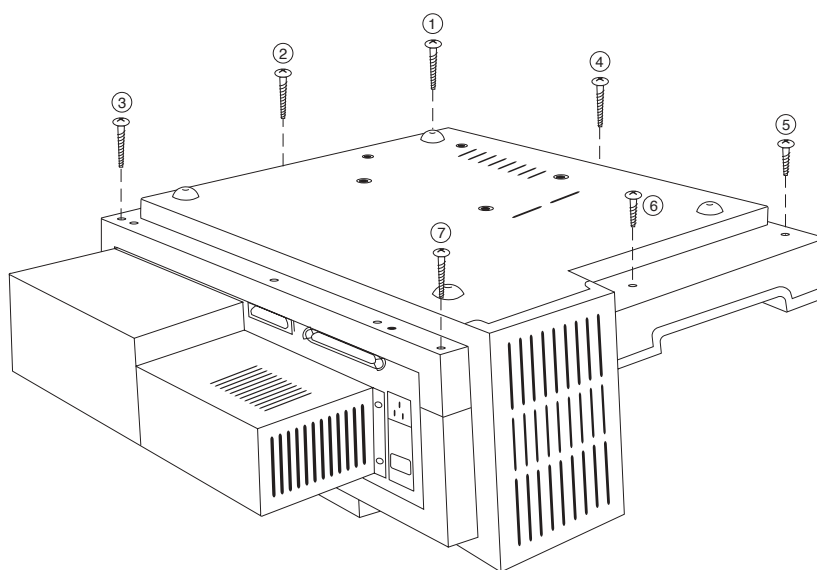


Figure 7.2: Underside of the Microplate Reader. This illustration shows the location of the seven screws that need to be removed before separating the top and bottom halves of the casing. Note: depending on the model you have, the back of the plate reader may not look exactly like this.

- 5) Firmly holding the upper and lower portions of the case together, turn the instrument back over to the normal operating position.
- 6) Examine Figure 7.3 before performing this step. Carefully lift the upper portion of the MAXline Microplate Reader about eight inches straight up over the lower portion. Then move the upper portion straight back behind the lower portion and place it down.

⚠ CAUTION: Do not attempt to separate the two casing halves by more than 8 inches. A flat ribbon cable connects the lower portion of the instrument to the control panel. **Do not attempt to disconnect this ribbon cable.**

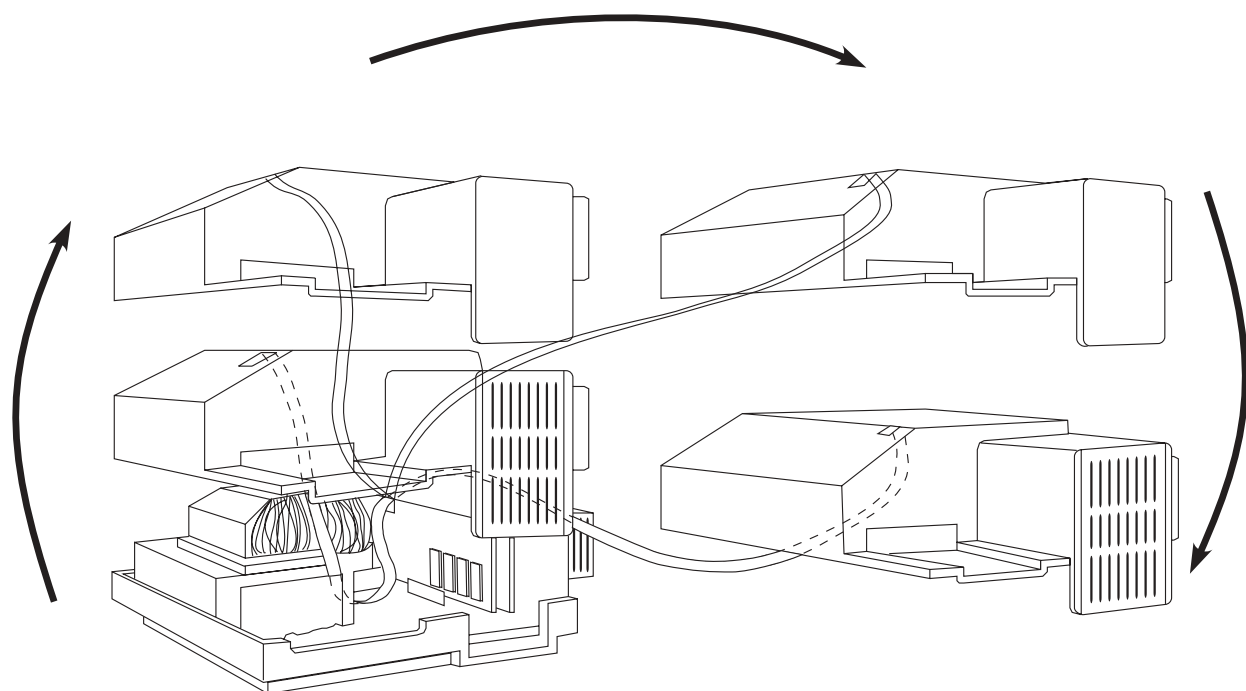


Figure 7.3: Separating the MAXline Microplate Reader Casing. Note the attachment of the ribbon cable and hence the importance of keeping the casing halves close together.

- 7) Locate the light source assembly at the rear left-hand side of the instrument as viewed from the front of the microplate reader.

NOTE: If installing a filter into an Emax or Vmax, the filter wheel housing will be clearly visible—you can skip to step 1 of the next section (Section II). If installing the filter into a THERMOmax, please follow steps 8 and 9, below.

- 8) For the THERMOmax, unfasten the spring-loaded holding clasps on the top and left side of the light chamber assembly as shown in Figure 7.4.

Tmax

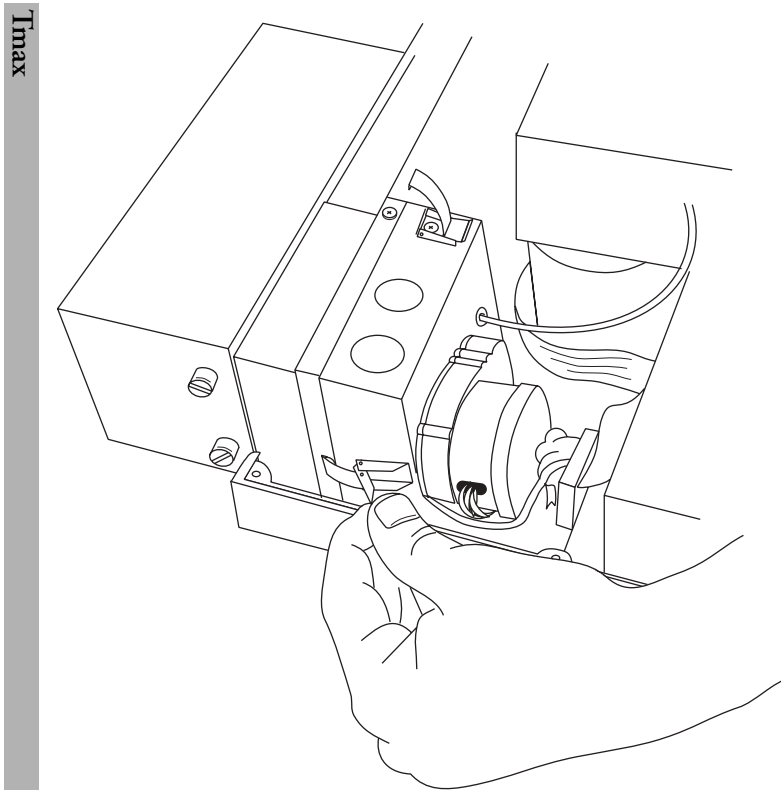


Figure 7.4: Light Source Assembly Spring Clamps

- 9) Grasp the front portion (nearest you) of the light source and gently slide it about two inches toward the front of the instrument as shown in Figure 7.5.

NOTE: The metal block of the light source is on a rail that curves inward slightly. This is normal.

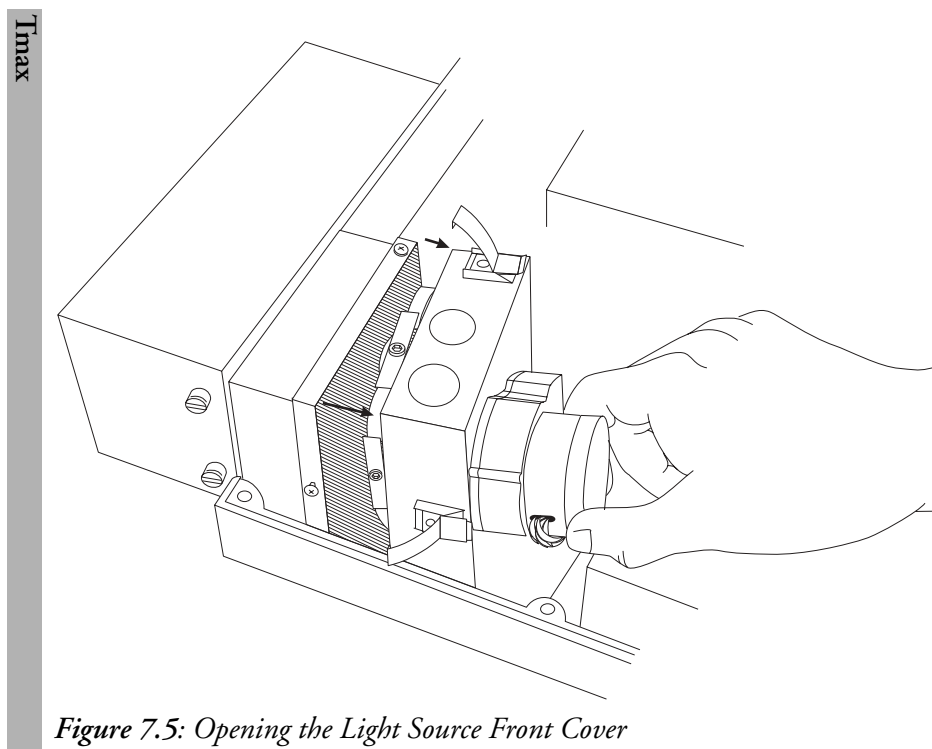


Figure 7.5: Opening the Light Source Front Cover

II. Install the Filter

- 1) The filter wheel housing and the filter wheel will be clearly visible. **Do not touch the surfaces of the filters.** Touching only the perimeter of the filter wheel, turn the wheel so that the filter slot with the black plastic disk (or the filter you are replacing) is in the top or highest position of the filter wheel.
- 2) Using a 3/32-inch hex wrench, **LOOSEN** the hex-head screw securing the bracket over the appropriate filter slot (about two full turns). Refer to Figure 7.6.

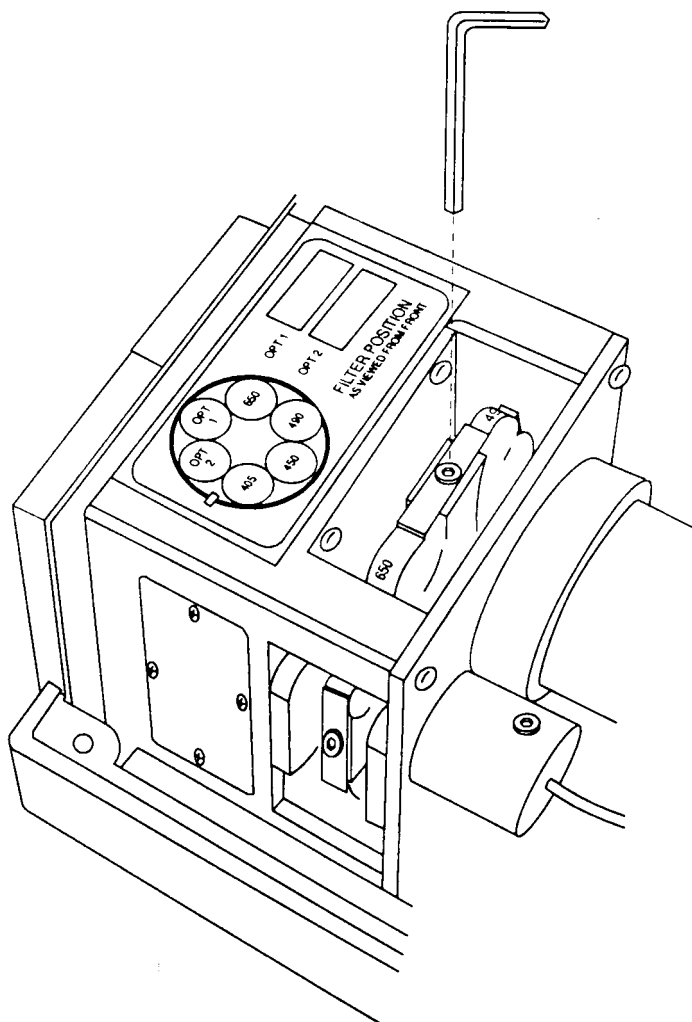


Figure 7.6: Filter Wheel Housing

- 3) **DO NOT REMOVE THIS SCREW OR THE BRACKET(S).** Turn the bracket sideways as shown in Figure 7.7.

NOTE: The home position (or Filter position #1) has only one bracket: on the right side of it is a vertical flag.

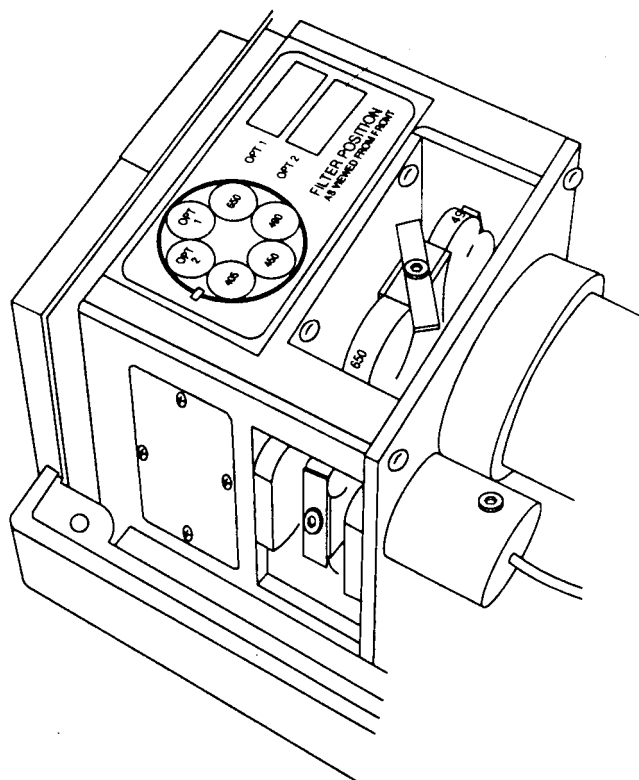


Figure 7.7: Filter Wheel Housing with Bracket Turned Sideways

- 4) Make a note of the position where you are installing the filter. **You will need this information to update SOFTmax or SOFTmax PRO software and the instrument keypad.** When counting the filters, the filter to the left of the vertical flag is #1 ~~and the filter positions are then counted clockwise from 1 to 6.~~
- 5) Unpack the filter to be installed, being careful not to touch either optical surface. Inspect the filter: both surfaces should appear flat and monocolored. Identify the recessed side and the flat side of the filter. Also, note the wavelength in nanometers printed on the outer face of the metal ring around the filter. These features help orient the filter for installation.
- 6) Turn the filter so that it is parallel to the appropriate open slot on the filter wheel and so that **the recessed side faces the front of the microplate reader while the flat side faces the reader.** When properly oriented, the wavelength printed on the perimeter can be read from the front of the microplate reader. Carefully insert the filter into the open slot in the filter wheel (see Figure 7.8).

max

NOTE: For the 340nm filter, both sides of the filter are recessed.

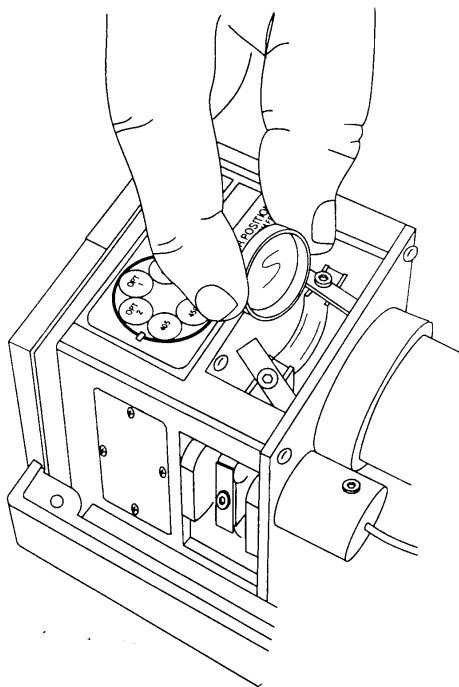


Figure 7.8: Installing the New Filter into the Filter Wheel

- 7) Turn the bracket back to the original position over the new filter and use the hex wrench to tighten the screw which holds the bracket. Repeat for all filters installed.
- 8) Gently spin the filter wheel to make sure it moves freely and to ensure that the optional filter has been seated correctly in the filter slot.

III. Reassemble the Microplate Reader

- Tmax

 - 1) Holding the clasps, gently slide the light source front cover on its rail to the point where it fits into the matching half.
 - 2) Replace the spring-loaded holding clasps on the front and side of the chamber assembly.
 - 3) Reexamine Figure 7.3 prior to this step. Pick up the top cover and carefully position it directly over the lower portion of the microplate reader without putting any stress on the ribbon cable. Be sure to align the two halves carefully on all edges before lowering the top cover into place.
 - 4) Holding the upper and lower portions of the microplate reader firmly together, turn the instrument upside down.
 - 5) Insert and tighten all seven screws in their slots. Recall that two of the screws are shorter, see Figure 7.2 for proper placement.
 - 6) Turn the microplate reader right-side up and reconnect the power cable and printer or computer cable.

IV. Update the Instrument Keypad

It is very important that the correct position of the filter installed be indicated on the instrument keypad.

- 1) Note where the filter is in the filter wheel (determined in Section II, Step 3, above).
- 2) Place the sticker that came with the filter or a piece of tape with the wavelength written on it next to the appropriate number on the front pad of the microplate reader.

V. Update the Software

If you are using the instrument in stand-alone mode, you are done with filter installation. If you are controlling the instrument with SOFTmax software, please read the following section. **It is very important that the filter you have installed in the microplate reader be called out in the software in the correct manner. The filter values in the software must match the positions of the filters in the filter wheel.**

Instructions for SOFTmax for Windows or Macintosh Software

- 1) Launch the SOFTmax program.
- 2) Select *Filters* under the CONTROL menu.
- 3) Type the wavelength of the filter you have just installed into the appropriate position on the filter list and click OK. The position in this list **MUST** match the position of the filter on the filter wheel as noted in Section III, step 3, above.
- 4) Select *Instrument* under the SETUP menu. Your new filter should be available under the wavelength drop menu.

Instructions for SOFTmax PRO Software (Windows or Macintosh)

- 1) Launch the SOFTmax PRO program.
- 2) Select *Preferences* under the EDIT menu. Click on the **Filter** button.
- 3) Type the wavelength of the filter you have just installed into the appropriate position on the filter list. The position in this list **MUST** match the position of the filter on the filter wheel as noted in Section III, step 3, above.
- 4) Select *Instrument Setup* from the CONTROL menu, or press the **Instrument Setup** button on the Plate Section. Your new filter should now be available in the WAVELENGTH menu.

NOTE: Filter wavelengths in this menu appear in numerical order, not the order in which they are installed in the filter wheel.

Changing the Lamp

Tmax

Instructions for THERMOmax

- 1) Switch the instrument off. Remove the power cord from the wall socket and then from the instrument's power port.
- 2) Turn the instrument around so you can reach the back of it easily. Remove the printer cable and/or computer cable (if connected) from the back of the instrument (it isn't essential to do this, but it does make it easier to change the lamp).
- 3) On the right hand side of the rear panel (as you face the back of the instrument) is a metal cover secured by two spring screws. Underneath the cover is the lamp assembly. Loosen the screws and gently slide the cover to the right, then pull it towards you to disengage it from the instrument (see Figure 7.9).

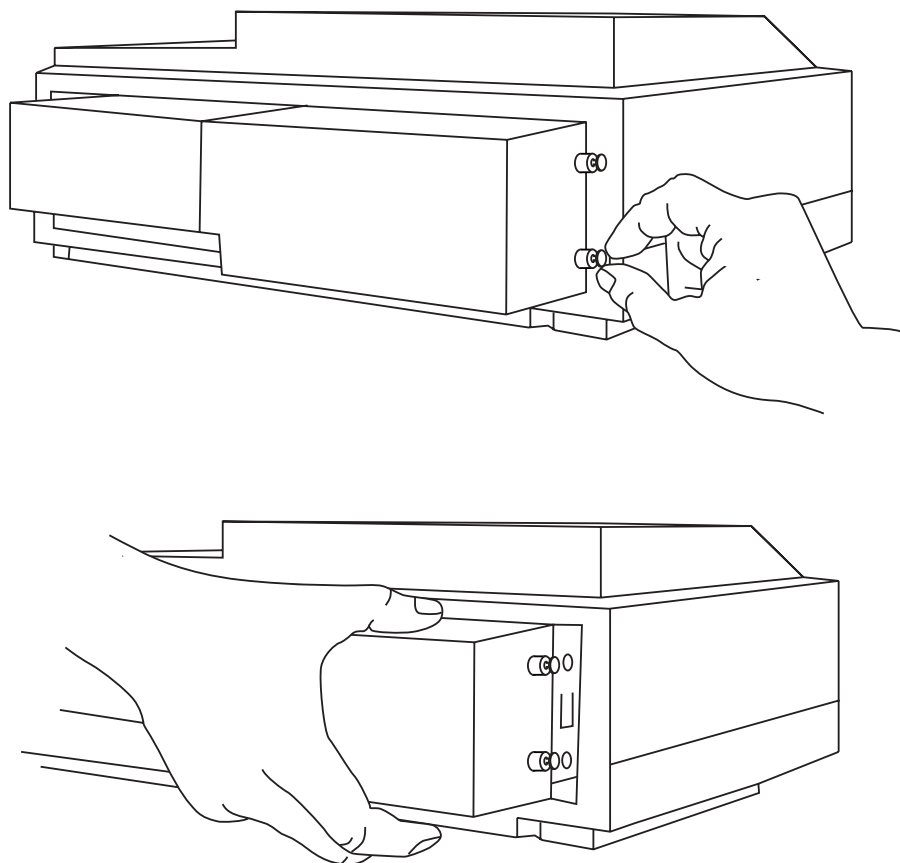


Figure 7.9: Removing the Lamp Cover

Examine Figure 7.10. Locate the lamp ejection lever on the right side of the lamp assembly. Gently depress the lever, then grasp the lamp by the white ceramic base as it is ejected.

Tmax

- ⚠ **WARNING:** Do not touch the lamp bulb while removing the lamp!
The bulb may be hot.
- Discard the burned-out lamp.

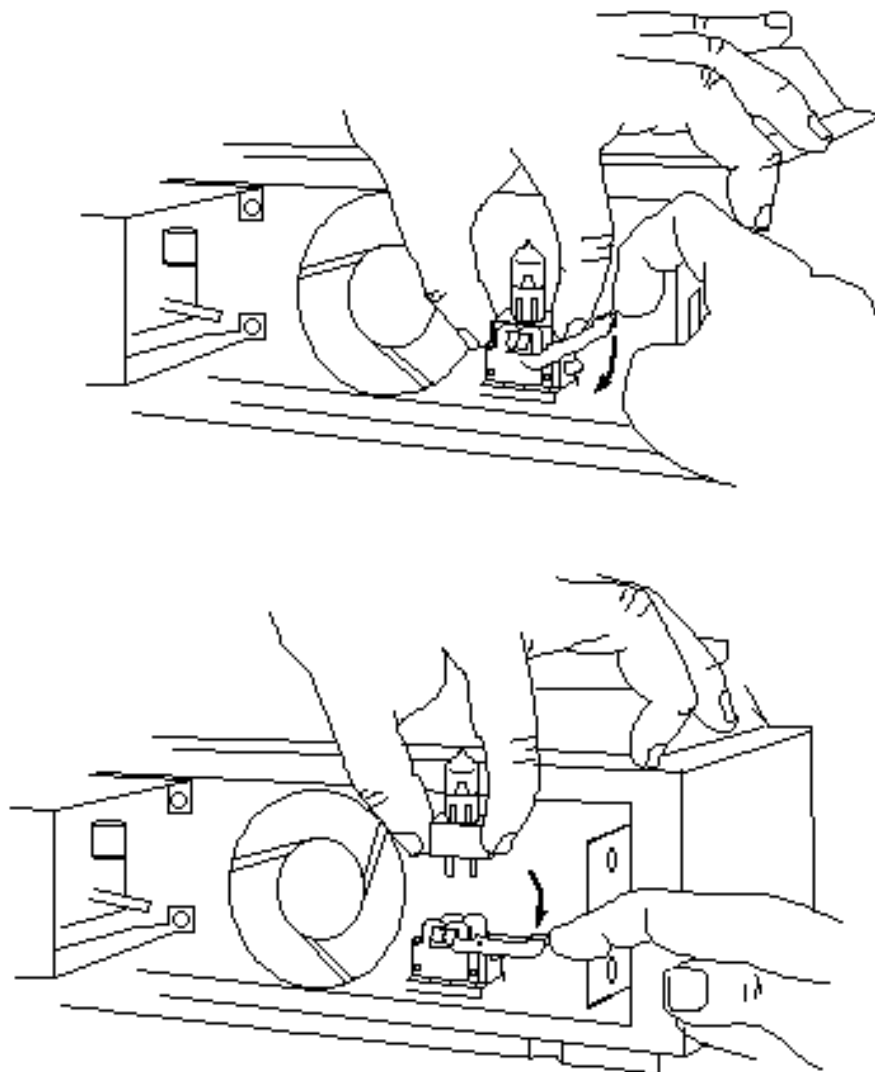


Figure 7.10: Removing the Burned-Out Lamp

- 4) Pick up the new lamp by its ceramic base.

- ⚠ **CAUTION:** Do not touch the glass portion of the new lamp, because fingerprints will degrade the lamp's performance.

- 5) Note that the two pins that protrude from the base are of different thicknesses, and that the corresponding sockets for the pins are of different diameters. Orient the pins in the correct sockets and gently push the new lamp into place (Figure 7.11). The ejection lever will automatically move to its original position.

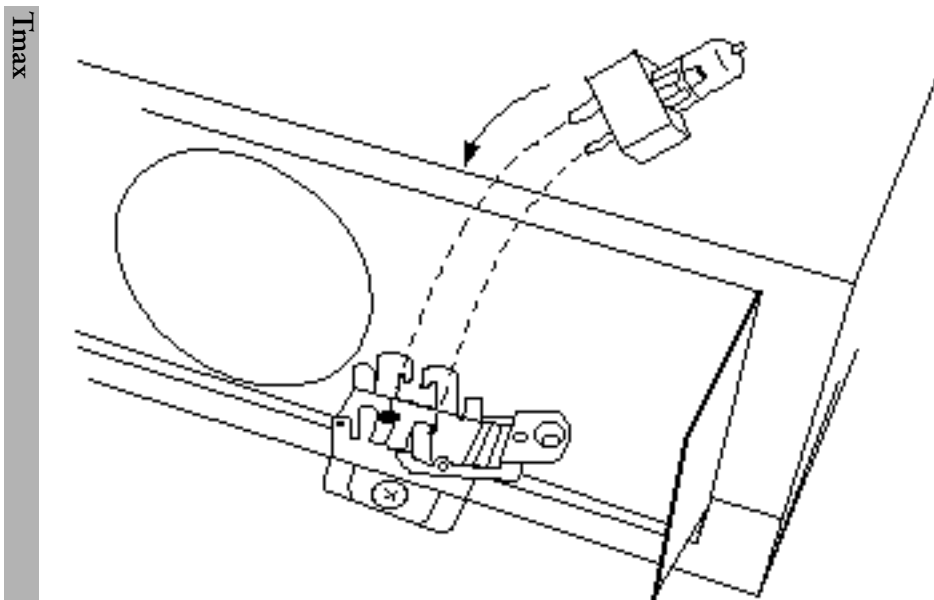


Figure 7.11: Installing the New Lamp

- 6) Reposition the metal cover over the lamp, then tighten the spring screws.
- 7) Reconnect the power cable to the instrument and the wall socket. If using the instrument with a computer/printer, reconnect their cables to the instrument.
- 8) Turn on the instrument (and computer, if using one), then test the new lamp by performing an endpoint read. Use the lowest available wavelength to ensure the most rigorous test of the new lamp.

Instructions for Emax and Vmax

- 1) Switch the instrument off. Remove the power cord from the wall socket and then from the instrument's power port.
- 2) Turn the instrument around so you can reach the back of it easily. Remove the printer cable and/or computer cable (if connected) from the back of the instrument (it isn't essential to do this, but it does make it easier to change the lamp).
- 3) Turn the instrument around so you can reach the back of it easily.
- 4) On the right hand side of the rear panel (as you face the back of the instrument) is a metal plate secured by two screws. The plate covers the lamp assembly (see Figure 7.12). Use a Phillips screwdriver to remove the screws, then remove the plate from the instrument.

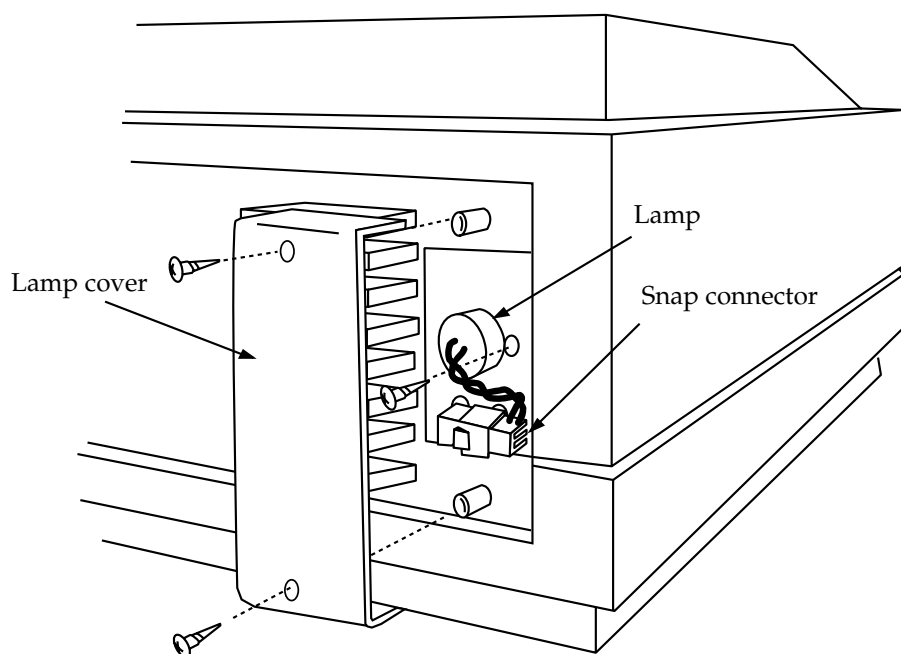


Figure 7.12: Removing the Lamp Cover (E_{max}/V_{max})

- 5) Remove the lamp screw (on the right side of the lamp, refer to Figure 7.12) then gently pull the connecting wires to remove the lamp from the body of the instrument.
- 6) Firmly grasp the snap connector beside the snap, then push the snap down with your thumb and pull the male and female halves of the connector apart (see Figure 7.13).

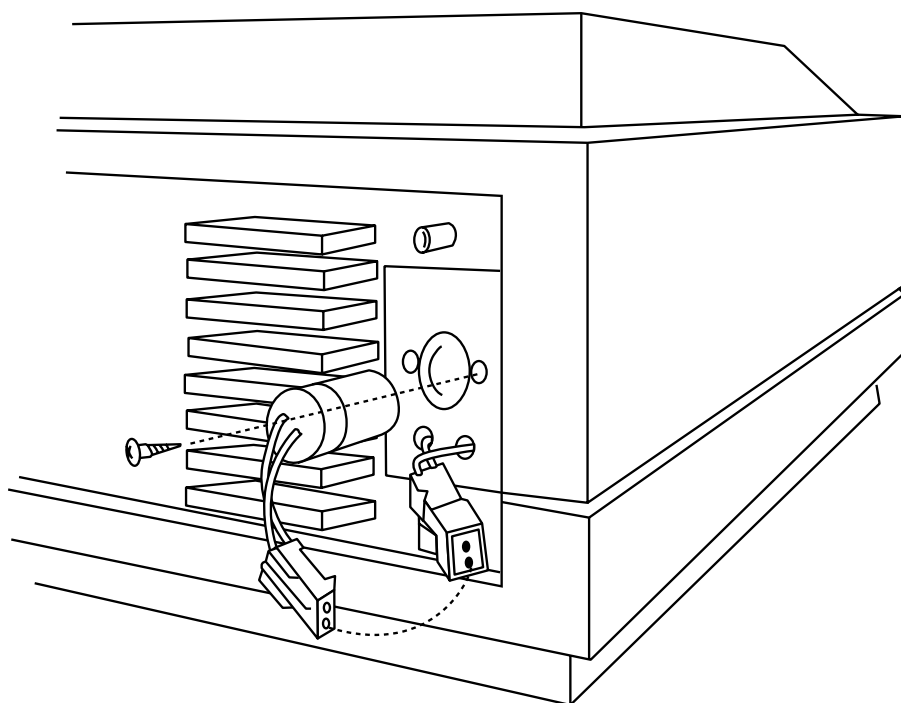


Figure 7.13: Removing the Burned-Out Lamp (E_{max}/V_{max})

- 7) Discard the burned-out lamp, then connect the new lamp to the snap connector.
- 8) Position the new lamp in the socket in the instrument, then secure it with the lamp screw.
- 9) Replace the lamp cover and secure it with the two Phillips screws. It's ok to bend the lamp wires to the side so that the cover fits.
- 10) Reconnect the power cable to the instrument and the wall socket. If using the instrument with a computer/printer, reconnect their cables to the instrument.
- 11) Turn on the instrument (and the computer, if using one), and then test the new lamp by performing an endpoint read. Use the lowest available wavelength to ensure the most rigorous test of the new lamp.

Changing the Fuse

Fuses burn out occasionally and need replacement. If upon switching the instrument on you have no indication that the instrument is getting power (power light and other control panel lights not on), first check to see that the power cord is securely plugged in to a functioning power outlet and to the power port at the rear of the MAXline Microplate Reader. If power failed while the instrument was already on, check to ensure the power cord has not been loosened or disconnected and that power to the power outlet has not been cut off. If these checks fail to remedy the loss of power, follow the steps listed below and, if necessary, replace the fuses. Spare fuses are shipped with

the instrument in the original carton. They may be taped to the back of the MAXline Microplate Reader.

NOTE: If a fuse has blown in the instrument, Molecular Devices recommends removing and reinstalling both fuses, not just one, to ensure continued proper operation.

If you no longer have spare fuses, new ones may be obtained from Molecular Devices. For THERMOmax, order a 3AT 5 mm x 20 mm (SloBlo) fuse; for Emax and Vmax, order a 1AT 5 mm x 20 mm (SloBlo) fuse.

- 1) Switch power to the instrument off and then remove the power cord from the outlet and from the microplate reader power cord receptacle.
- 2) Remove the printer cable and computer cable (if connected) from the back of the MAXline Microplate Reader.
- 3) Turn the instrument around for easy access to the rear panel.
- 4) On the left-hand side of the rear panel (viewed from the back) is the power cord receptacle. As shown in Figure 7.14, insert a small, flat-bladed screwdriver into the slot above the switch at the top of the black plastic cover. Gently pry the cover open. The cover will hinge down, allowing you to see the fusebox inside.

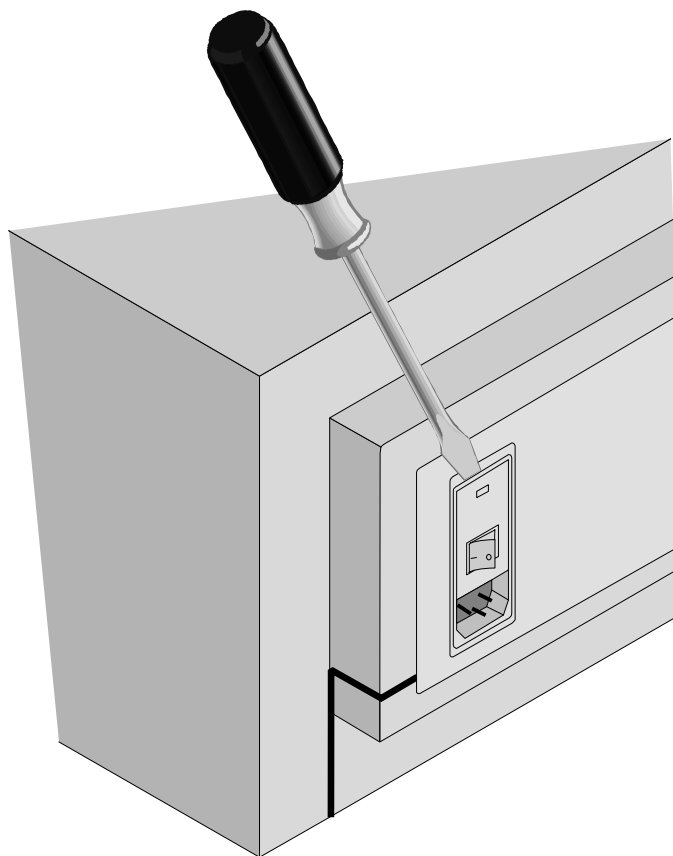


Figure 7.14: Pry Open the Fuse Box Cover

- 5) Insert the blade of the screwdriver into the small slot on the top front of the fuse box. Pull the fusebox toward you, out of the instrument. When removed, the fuse assembly will appear as shown in Figure 7.15.

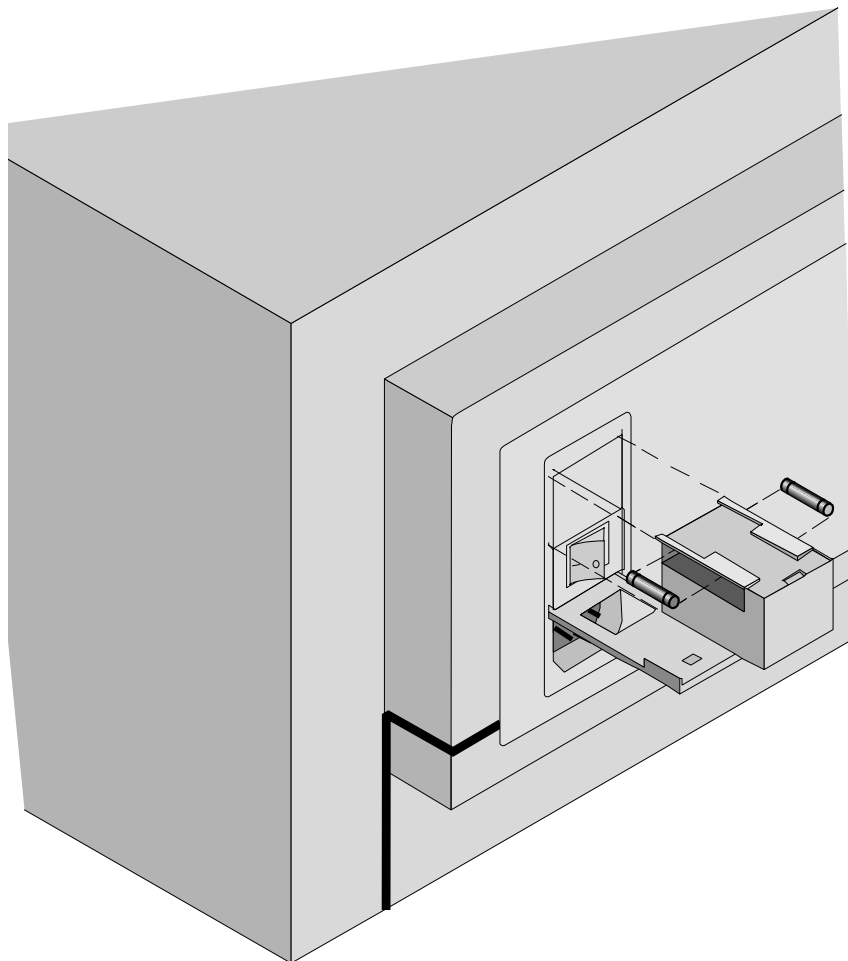


Figure 7.15: Removing the Fuse Box

- 6) The fuses are located on the top sides of the holder. While it is possible that only one fuse may have blown, Molecular Devices recommends that you replace both fuses to ensure continued proper operation. Pull both fuses out of the holder and discard them.
- 7) Insert new SloBlo-rated fuses into the fuse holder. Either end of the fuse may be forward.
- 8) Insert the fuse holder into the fuse box, making sure that the fuses are closest to the top of the holder and the removal slot is toward you. Slide the fuse holder all the way into the box.
- 9) Lift the cover and press it into place, making sure the cover snaps closed.
- 10) Reconnect the power cord to the instrument and to the wall outlet and reconnect other cables previously disconnected.

Removing the Drawer Subplate

Tmax

The microplate drawer subplate has been designed and developed for the THERMOmax microplate reader to maintain the temperature uniformity of the microplate. Without the subplate in the microplate drawer, the temperature across the microplate may not be uniform. The microplate drawer subplate can be removed if it interferes with the secure placement of a microplate in the drawer or to clean the drawer carriage and the subplate.

Turn the THERMOmax on and the INCUBATOR off. If the drawer is closed, the microplate drawer can be opened by touching the DRAWER key. Place the threaded subplate removal tool in the A1 position of the subplate. That position is marked on the drawer carriage. Turn the subplate removal tool 3 full turns until it holds the subplate securely. With one hand, compress the spring nearest you on the microplate drawer and, with the other hand on the subplate removal tool, pull the subplate out of the drawer.

To return the microplate subplate to the drawer, open the microplate drawer of the THERMOmax. Place the subplate in the microplate drawer matching the notches with the microplate drawer springs. Press the subplate into the drawer.

Chapter 8 Troubleshooting

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Warnings and Cautions

- ⌘ **BIOHAZARD:** 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 Corporation.
- ⌘ **BIOHAZARD:** Always wear gloves when performing any type of service, especially if it involves potential contact with spilled fluids or fluid residues of any kind.
- ⚠ **WARNING:** Always turn the instrument off and remove the power cord from the back prior to any maintenance or installation operation.
- ⚠ **WARNING:** Do not attempt to service the System I instrument yourself except as explained in this manual. Always follow installation and servicing instructions closely. Use only the tools described to perform the steps defined in the instructions.
- ⚠ **WARNING:** Never perform any operation on the instrument in an environment where liquids or potentially damaging gases are present.
- ⚠ **WARNING:** Risk of electrical shock, Refer servicing to qualified personnel.
- ⚠ **CAUTION:** Never touch any of the fiber optic cables or their housing, manifold, or rotor connections. These fibers are extremely delicate and critical to the performance of the instrument.
- ⚠ **CAUTION:** Do not touch or loosen any screws or parts other than those specifically designated in the instructions. Doing so could cause misalignment and possibly void warranty.
- ⚠ **CAUTION:** Never touch the surfaces of the reference filters or optical lenses.
- ⚠ **CAUTION:** Handle components and cards with care. Don't touch the components or contacts on a card. Hold a card by its edges or by its metal mounting bracket.

General Information

This chapter provides troubleshooting procedures for your MAXline Microplate Reader. *Before you start any of the procedures in this chapter, read the safety instructions in “Safety First—For You and Your Instrument” found next in this chapter.*

The problems that you may encounter while using one of the MAXline Microplate Readers can be divided into two categories: those which generate an error message (either printed or on screen) and those that do not. The sections in this chapter deal with these types of problems separately. The exact text of an error message will depend on whether the instrument is being used in stand-alone mode or is controlled by SOFTmax or SOFTmax PRO software. Tables and charts in each section should assist you in locating the source of the problem and provide you with a solution.

If you are unable to find the information you need or, if after following the steps in the tables and charts, you are still unable to determine the cause of the problem or remedy it, contact Molecular Devices Technical Support Department for assistance. Some problems are not user-serviceable and the troubleshooting table or chart may direct you to contact the Molecular Devices Service Department for assistance. To reach the Molecular Devices Technical Support or Service Departments, in the U.S., call 800-635-5577; elsewhere, call your local representative.


Safety First— For You and Your Instrument

Some of the procedures in this chapter require that you open the cover of the MAXline Microplate Reader and remove and/or install components. While working inside the instrument, do not attempt to service the instrument except as explained in this manual. Always follow the instructions closely. Working inside the instrument is safe—if you observe the following precautions.

WARNING FOR YOUR PERSONAL SAFETY AND FOR THE PROTECTION OF YOUR EQUIPMENT

Before starting to work on your System I instrument, perform the following steps in the sequence indicated:

- 1) *Turn off* your MAXline Microplate Reader (and computer, if connected to the MAXline Microplate Reader) and all peripherals (e.g., printer, etc.)
- 2) *Disconnect* the MAXline Microplate Reader, computer, and other peripherals from their power sources. Doing so reduces the potential for personal injury or shock.
- 3) *Touch* an unpainted metal surface on the instrument chassis before touching any computer boards inside the MAXline Microplate Reader in order to dissipate any static electricity that might harm such internal components.

 **CAUTION:** PROTECTING AGAINST ELECTROSTATIC DISCHARGE. Static electricity can harm delicate components inside your MAXline Microplate Reader. To prevent static damage, discharge static electricity from your body before you touch any electronic components, such as boards or cards. You can do this by touching an unpainted metal surface to remove any static charge your body may have accumulated. When transporting a sensitive component, first place it in an antistatic container or packaging.

In addition, Molecular Devices recommends that you periodically review the safety instructions, cautions, warnings, etc., contained within this manual.

Printed or On-Screen Error and Warning Messages

Error Messages Covered in This Section

If a problem occurs during operation that causes an error, the instrument will stop and most often an error message will be printed or shown on the computer screen. Some errors are caused by equipment malfunction and others result from incorrect operation. In all cases, should the prescribed resolution listed in this chapter fail to correct the problem, please call Molecular Devices Technical Services group at 800-635-5577 (U.S.) or call your local representative.

The first step after receiving an error message is to follow the troubleshooting chart associated with that message. Some of these charts contain information that is covered in greater detail in the sections following the charts (annotations appearing on the charts refer you to detailed procedures in this manual).

The actual text of an error message can differ, depending upon whether you are running the instrument in standalone mode or via software run on a computer (the software version or computer platform can also cause messages to differ). For example, should something block the drawer from opening, the resulting error message might say, “Drawer—Not in or Jammed,” or “Run Aborted—Drawer Transport Failed (Error 4).” Do not be concerned if the actual text of the error message you receive is not exactly like that printed here. Locate the section pertaining to the error message you received in one of the tables below (corresponding to your particular instrument) and follow the troubleshooting information found there.

Table 8.1: Printed Error Messages and Corresponding Troubleshooting Information (Emax and Vmax)

Error Message	Troubleshooting Chart / Remedy
Drawer not in or jammed Run aborted—drawer transport failed (Error 4)	See Chart 1 on page 8-8.
Insufficient light—burned out lamp Power up failure—insufficient light: check lamp Insufficient light: check for valid filter selection (Error 7) Check for burned out lamp (Error 3)	See Chart 2 on page 8-11.
Single well bad channel or insufficient light Run aborted—Insufficient light in well XX (Error 20)	See Chart 3 on page 8-14.
Filter wheel missselect Run aborted—filter location error (Error 9)	See Chart 4 on page 8-16.
Run aborted upon user request	This message is printed or shown when the CANCEL function is implemented.
Run aborted—measurement timing error	The timing mechanism for the distribution of light is malfunctioning. This is caused by trauma, such as might result from dropping the instrument. This is NOT USER SERVICEABLE. Please call Molecular Devices.

Table 8.2 Printed Error Messages and Corresponding Troubleshooting Information (THERMOmax)

Tmax	Error Message	Troubleshooting Chart / Remedy
	<p>1. Warning: fan failure; chamber may not have been isothermal during run</p> <p>2. Run aborted—fan failure; incubator not operational—to read without incubator, press READ key</p>	<p>See Chart 5 on page 8-18.</p> <p>Message 1 appears after the data has been printed. A diagnostic review of the instrument operation during the read indicates that the ventilation fan to the microplate chamber has failed. Message 2 appears after the READ key is pressed or the incubator is turned on.</p> <p>The fan is critical for the proper operation of the microplate chamber temperature regulation. Because of the fan failure, the incubator will be turned off and will not be operational. The THERMOmax can still read microplates, but without temperature regulation.</p>
	<p>NOTE: The microplate chamber ventilation fan is needed to prevent condensation of volatile solvents on the optical surfaces of the microplate chamber. In addition, the fan distributes the air within the microplate chamber to assure temperature uniformity when the incubator is off.</p>	
	Warning: microplate chamber may not have been within temperature regulation	<p>The temperature of the microplate chamber has fallen out of specification (set point $\pm 0.3^{\circ}\text{C}$) during the run. Temperature regulation of the chamber was not properly maintained during the entire course of the run.</p> <p>Cause 1: The incubator was turned off and then on again just before the read. A brief power failure or pushing the INCUBATOR key will cause the temperature control algorithm to reset. The temperature within the microplate chamber may fluctuate for less than 10 minutes while the control algorithm re-establishes temperature regulation.</p> <p>Remedy 1: Allow the temperature control algorithm to regain control of the microplate chamber temperature.</p> <p>Cause 2: Failure of the heater during a run. The microplate chamber temperature drifted out of specification.</p> <p>Remedy 2: A heater failure error will be printed when the next check of the heater is made. Such a check can be made by turning the incubator off and then on again. If a heater failure error appears, refer to Chart 6 on page 8-20.</p>
	<p>1. Power up failure—heater failure; incubator not operational</p> <p>2. Heater failure; incubator not operational</p>	<p>See Chart 6 on page 8-20.</p> <p>Message 1 is printed when the THERMOmax is powered up and a diagnostic review of the instrument indicates that the heating element has failed. Message 2 is printed after the incubator is turned on.</p> <p>If not remedied, the THERMOmax can still read microplates but without temperature regulation.</p>
	Invalid set point entry	<p>While in Stand-alone mode, the THERMOmax could not interpret the Blank Pattern Template or the entry was invalid or out of range. The Temperature Set Point will not be changed until a valid Temperature Set Point is read.</p> <p>Check that the Blank Pattern Template has been properly prepared (see Set Temperature Selection on page 5-5).</p>

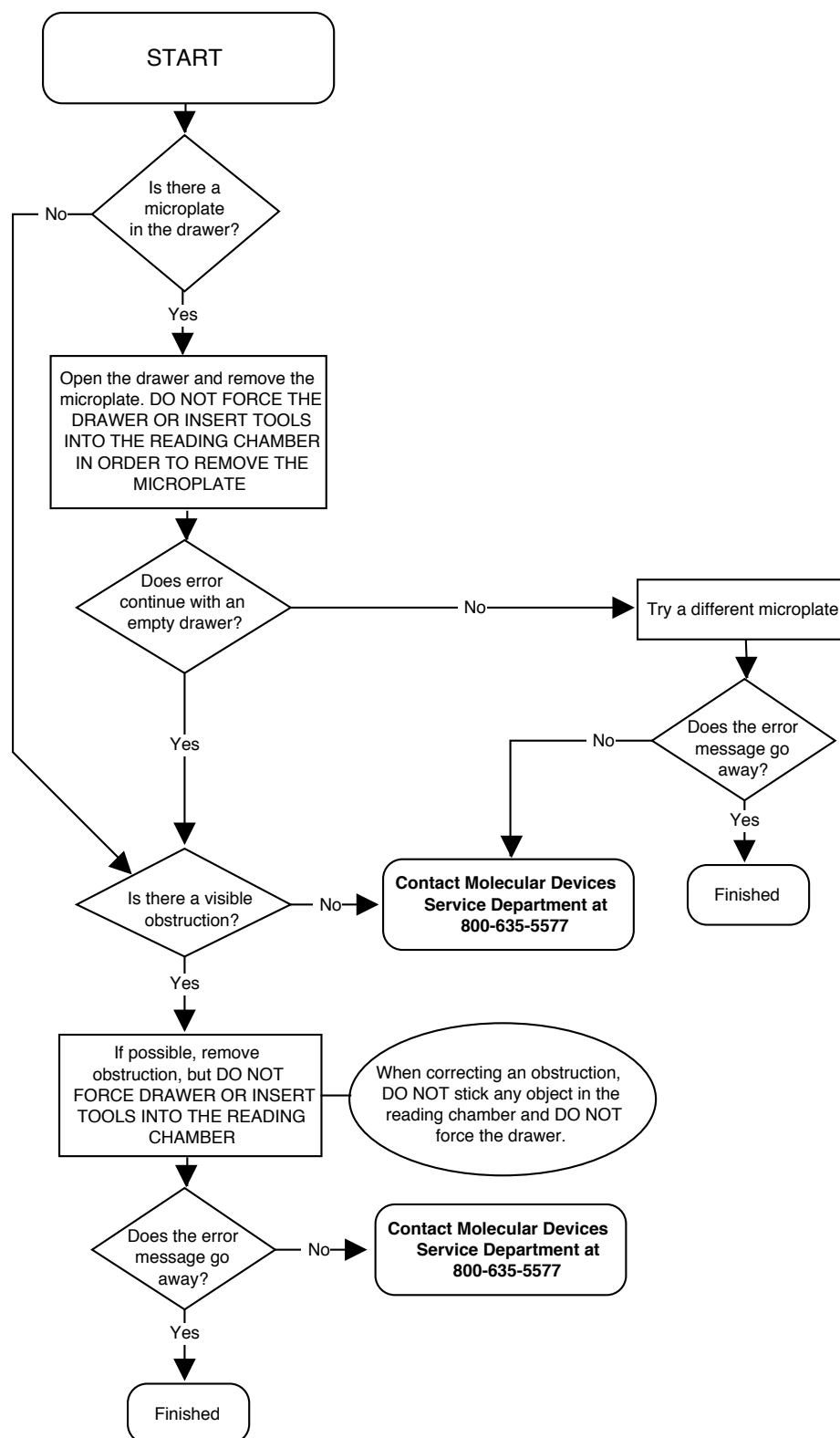
Chart 1: Drawer Not In or Jammed

This error message is printed when something stops or blocks the drawer transport carriage from moving into the reading chamber. A microplate not firmly seated or some other piece of labware that blocks the drawer will cause this message to be printed.

When blocked, the microplate reader switches OFF the drawer drive motor so that it does not burn out trying to overcome the blockage. If the drawer is blocked while leaving the reading chamber, the data from the run just completed is printed (when run in standalone mode) and the message does not appear. However, the drawer drive motor will still be switched off to prevent burnout.

Follow the instructions in the chart on the opposite page to determine the source of the problem.

Chart 1



[Charts continue on next page]

Chart 2: Insufficient Light/Burned Out Lamp
Check for valid filter selection (Error 7)
Check for burned out lamp (Error 3)

This error message is generally due to failure of the instrument lamp, either because the lamp has blown or because the light coming from the lamp is inadequate for readings at the selected wavelength. The error message can also occur if you have attempted to read through a position on the filter wheel that does not have a filter installed (a black plastic disk is used to fill the slot and no light can pass through. There may also be a problem with the filter itself.

Please note: The **average** life for the Emax/Vmax lamp is 4000 hours, which is about 16 to 20 months of regular usage. The **average** life for the THERMOmax lamp is 750 hours, which is about 4 to 6 months, depending on usage. Lamps have varying lifetimes and these specifications reflect only the average lifetime.

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart (following pages):

- 1) If you have any question regarding whether the filter configuration set up in either SOFTmax or SOFTmax PRO software matches the actual filters installed in the plate reader, please remove the top cover of the microplate reader and check the wavelengths of the filters in the filter wheel. Detailed instructions regarding this procedure can be found on page 7-4.
- 2) Use a source of clean, dry air such as canned air to blow into the reading chamber and remove any dust buildup. **See caution, below.** To do this, manually open the drawer about halfway (or, if the drawer is open, close it halfway) and blow the air into the reading chamber.


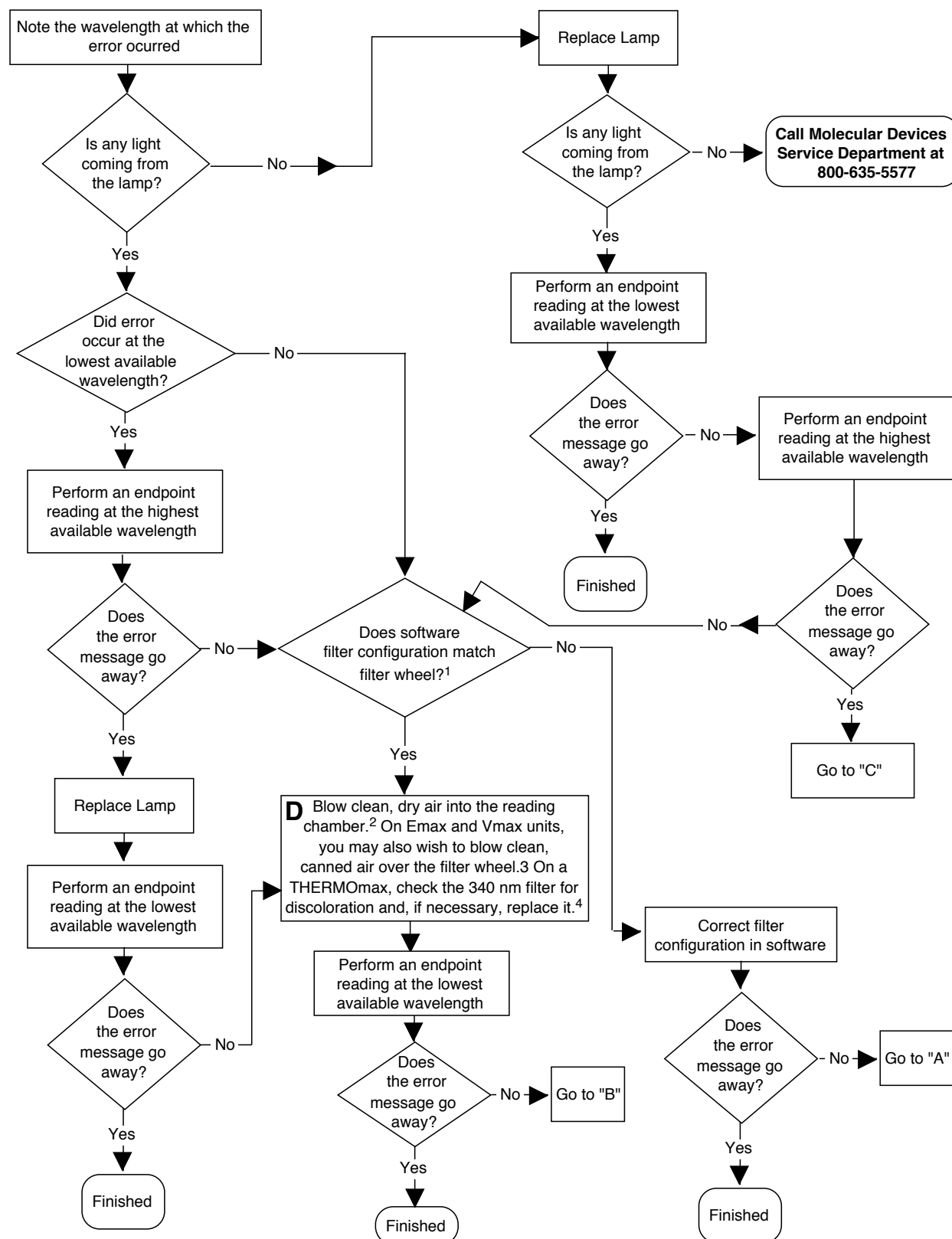
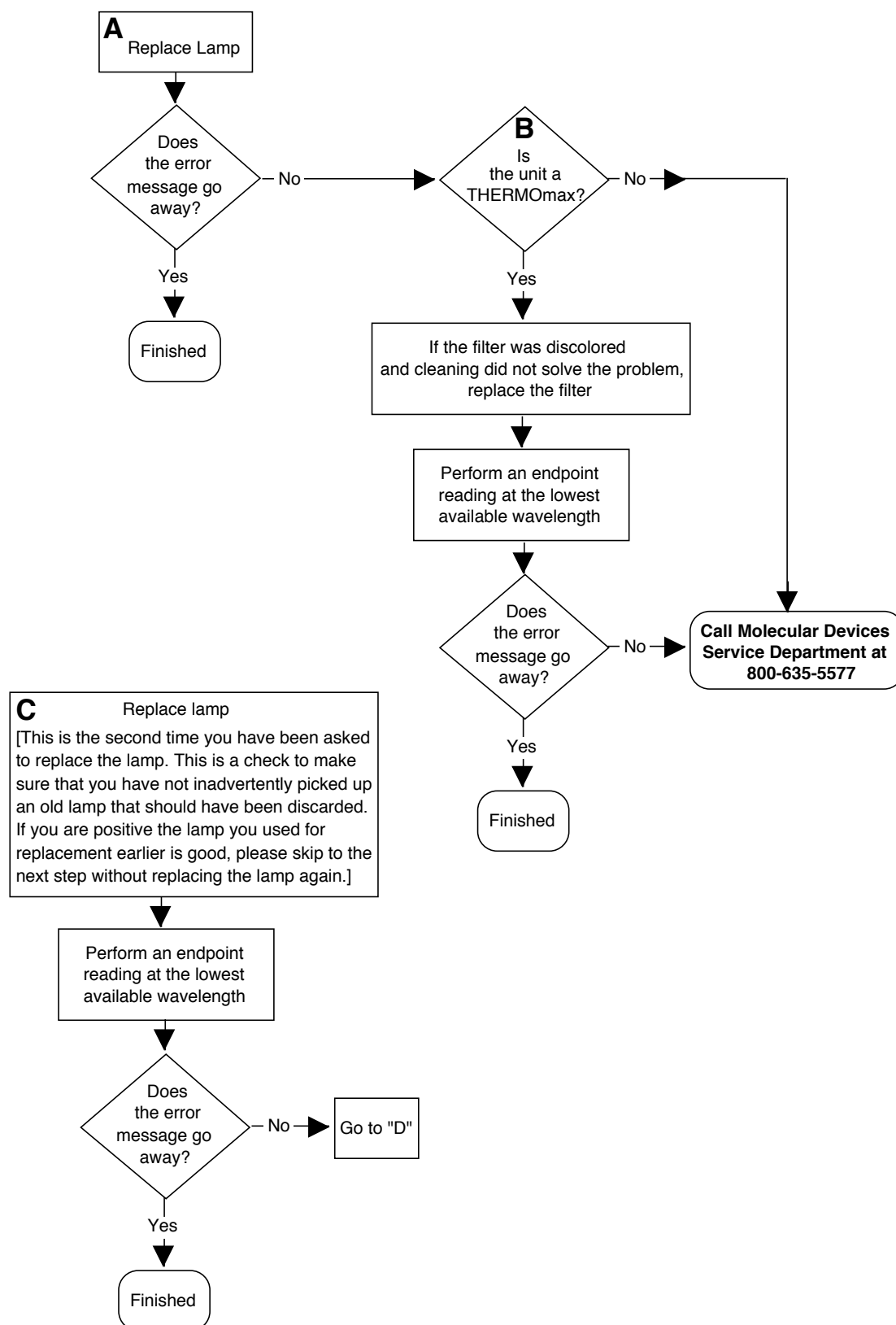
 **CAUTION:** If using canned air, please note the cautions regarding freezing listed on the label of the product before proceeding with this step.
- 3) On Emax and Vmax units, you may also wish to remove the top cover of the instrument and blow, clean, dry air over the exposed filter wheel. **See caution, above.** For instructions about removing the top cover of the microplate reader, please see page 7-4.
- 4) See “Cleaning an Optical Filter” on page 8-49 for detailed instructions about this procedure.

Chart 2





**Chart 3: Single Well, Bad Channel or Insufficient Light
Run Aborted– Insufficient Light in Well XX (Error 20)**


This problem is generally due to insufficient light in a single well. The problem may be due to dust/dirt buildup in the instrument, to a failure in the detector board, in the fiber optic stack, or in other circuitry corresponding to well location. If the error message only occurs at a low wavelength (such as 340 nm) and goes away at higher wavelengths, the problem may be due to insufficient light coming from the lamp or to a problem with the filter.

To override this error message, you may hold down the **PRINT BLANK PATTERN** key while powering up the microplate reader. However, please note that once you have done this, other bad wells will NOT be diagnosed.

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:

- 1) Use a source of clean, dry air such as canned air to blow into the reading chamber and remove any dust buildup. **See caution, below.** To do this, manually open the drawer about halfway (or, if the drawer is open, close it halfway) and blow the air into the reading chamber.

 **CAUTION:** If using canned air, please note the cautions regarding freezing listed on the label of the product before proceeding with this step.

- 2) On Emax and Vmax units, you may also wish to remove the top cover of the instrument and blow, clean, dry air over the exposed filter wheel and over the circuit boards and in the back of the instrument near the filter wheel. **See caution, above.** For instructions about removing the top cover of the microplate reader, please see page 7-4.
- 3) Both surfaces of the filter should be monocolored and shiny.
- 4) See “Cleaning an Optical Filter” on page 8-49 for detailed instructions about this procedure.

Chart 3

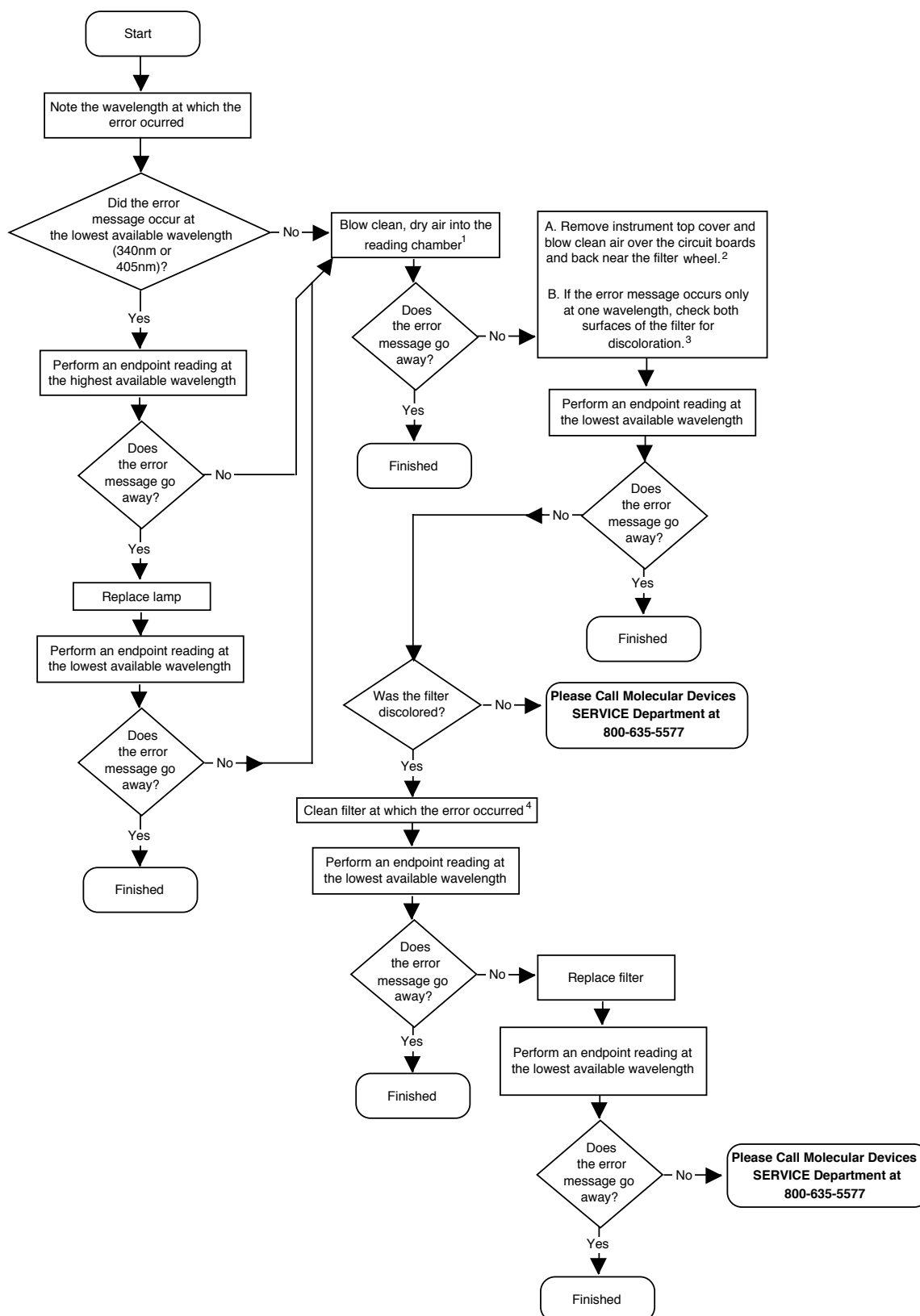



Chart 4: Filter Wheel Mismatch Run Aborted—Filter Location Error (Error 9)

This message appears if something prevents the filter wheel inside the instrument from turning properly. It occurs most often if a new filter has been improperly installed.

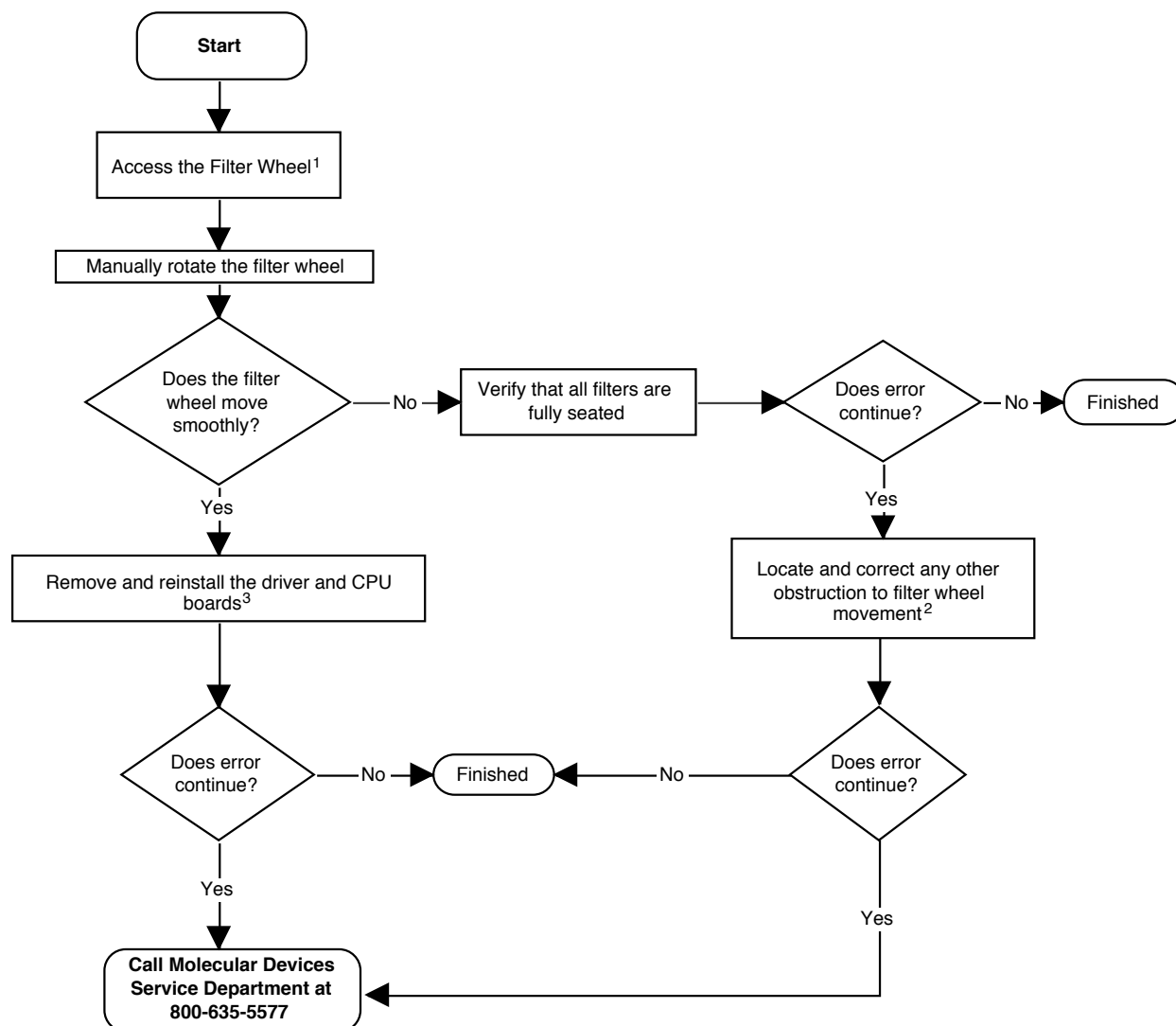
 **CAUTION:** You should attempt to remove a filter wheel blockage only if it is obvious and easily removed without touching the optical filters, lenses, or fiber optics. If it is not obvious, or removal appears difficult, please call Molecular Devices.

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:


- 1) Follow the instructions on page 7-4 to remove the top cover of the instrument and access the filter wheel.
- 2) If the filter wheel movement is not obstructed by a filter, check for other obvious obstructions. If the blockage is obvious and can be removed without touching any filters, lenses, or optical fibers, then remove it. If the blockage is not accessible or not obstruction is visible but the filter wheel does not move freely, then service is required.
- 3) Follow the instructions on page 8-51 to reseal the A2 driver board.

Chart 4



**Chart 5: Power Up Fan Failure; Incubator Not Operational
(Error 22—THERMOmax Only)**

This error message is printed at the time the THERMOmax is powered up. A diagnostic review of the instrument operation indicates that the instrument fan or the microplate chamber ventilation fan has failed. These fans are critical for the proper operation of the temperature regulation. Because of the fan failure, the incubator will be turned off and will not be operational. The THERMOmax can still read microplates, but without temperature regulation.

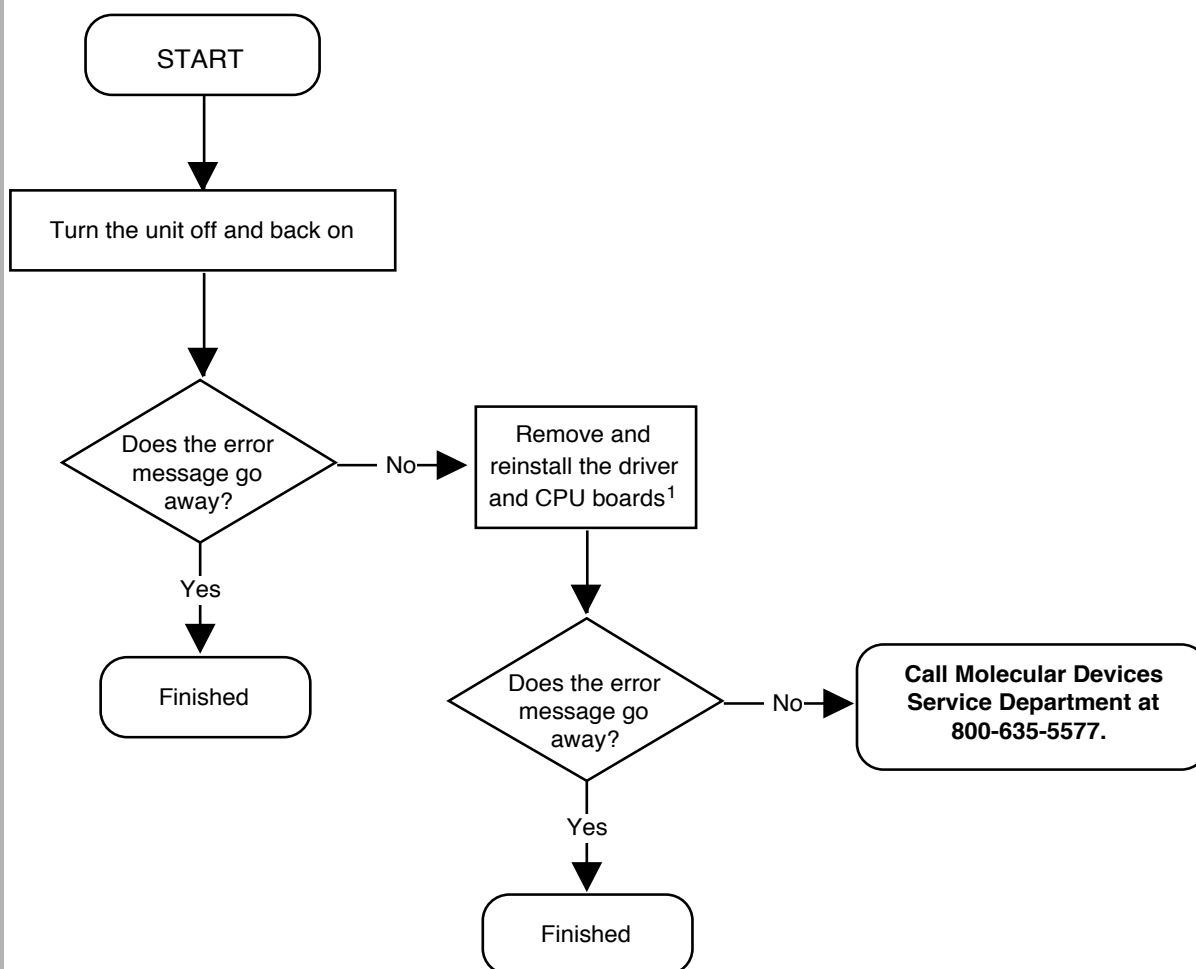
 **CAUTION:** The microplate chamber ventilation fan is needed to prevent condensation of volatile solvents on the optical surfaces in the microplate chamber. In addition, the fan distributes the air within the microplate chamber to assure temperature uniformity when the incubator is off.

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:

- 1) Follow the instructions on page 8-51 to reseal the A2 driver board.

Chart 5



**Chart 6: Heater Failure; Incubator Not Operational (THERMOmax Only)
To Read Without Incubator, Press READ Key**

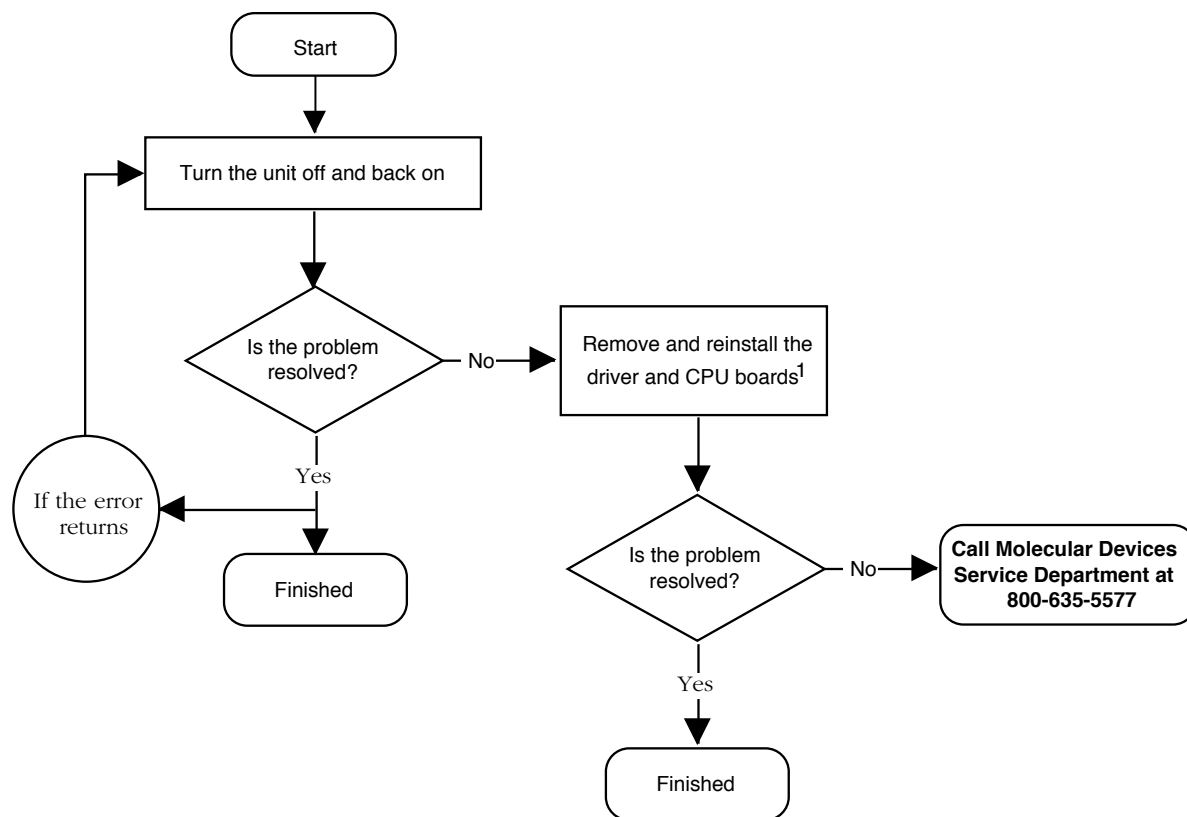
This error message is printed at the time the THERMOmax is powered up. A diagnostic review of the instrument operation indicates that the heater for the microplate chamber has failed. This heater is critical for proper operation of the temperature regulation. Because of the heater failure, the incubator will be turned off and will not be operational. The THERMOmax can still read microplates, but without incubation.

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:

- 1) Follow the instructions on page 8-51 to reseal the A2 and CPU driver boards.

Chart 6



Errors That Do Not Produce a Printed Message

Not all errors produce messages that are shown on the screen or printed. The following chart lists problems you may encounter when using the MAXline Microplate Reader and associated troubleshooting charts that will assist you in determining the cause of the problem and suggest possible remedies.

Table 8.3: Troubleshooting Information When No Error Message Is Produced

Problem	Troubleshooting Chart
All keypad LEDs remain lit after switching instrument on	See Chart 7 on page 8-25.
THERMOmax: No keypad LEDs at power up	See Chart 8 on page 8-27.
The fuse blows each time the instrument is turned on	See Chart 9 on page 8-29.
The instrument is making a loud, high-pitched noise or pinging	See Chart 10 on page 8-31.
Timed out error—no response from reader.	See Chart 11 on page 8-33.
Unable to establish communication with the reader when initially entering the software program (using a computer to control the microplate reader)	See Chart 12 on page 8-36; also see Communication Problems on page 8-46.
1. Abnormal OD readings in wells X, Y, Z 2. Endpoint ODs higher/lower than expected 3. Kinetic rates lower/higher than expected 4. Assay is lower/higher today than yesterday	See Chart 13 on page 8-39.
Noisy kinetic readings	See Chart 14 on page 8-41.

Chart 7: All keypad LEDs remain lit after switching instrument on

This problem usually occurs when either the driver board or ribbon cable leading to the board inside the instrument has become loose or disconnected. Most often reseating the driver board or making sure the ribbon cable connections are tight will solve the problem.

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:

- 1) Remove the top cover from the instrument following the instructions on page 7-4.
- 2) Reseat the ribbon cable and driver board by following the procedure on page 8-51.

Chart 7

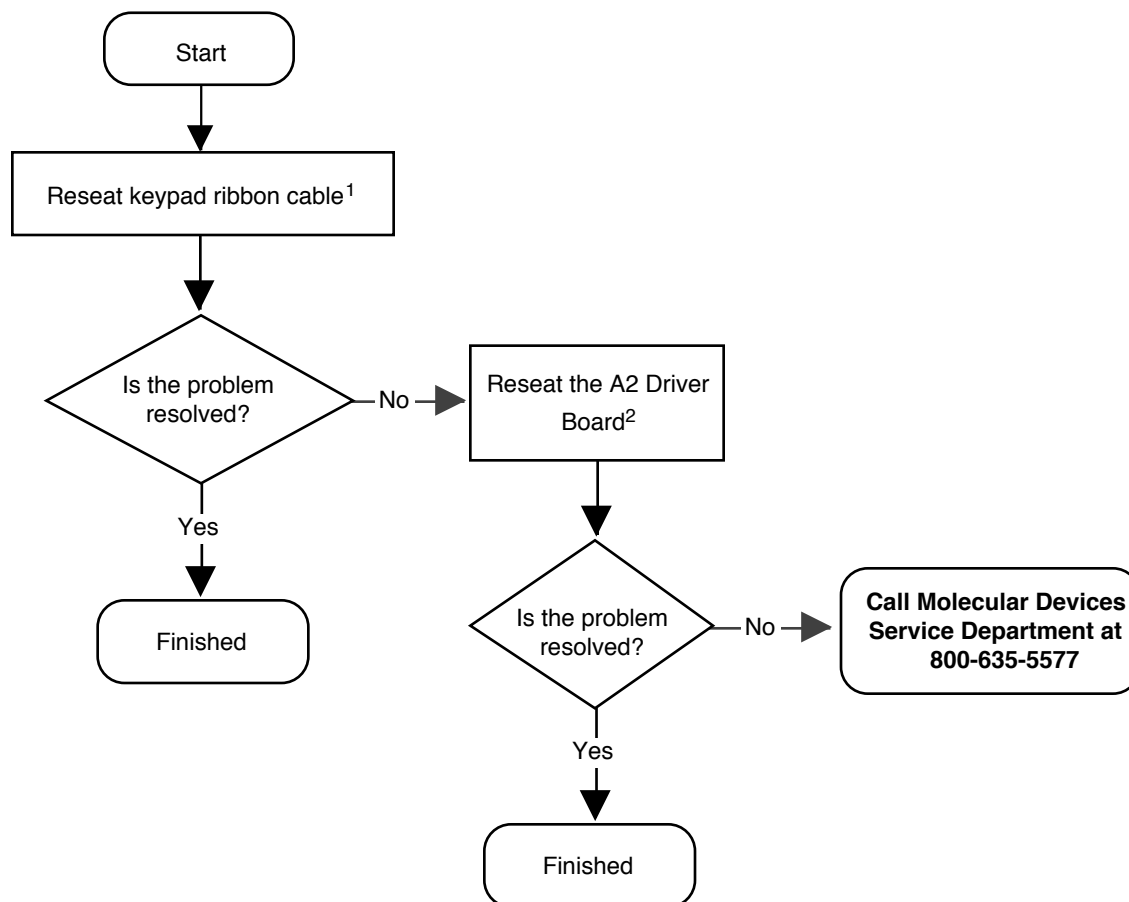


Chart 8: No keypad LEDs at power-up

This problem can occur when a fuse has blown or if one of the boards or cables inside the instrument has become loose or disconnected. Most often replacing fuses or reseating a board or cable will solve the problem.

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:

- 1) Remove the top cover from the instrument following the instructions on page 7-4. Reseat the ribbon cable by following the procedure starting on page 8-51.
- 2) Remove the top cover from the instrument following the instructions on page 7-4. Reseat the driver board by following the procedure starting on page 8-51.
- 3) Open the fuse box cover and check the status of the fuses following the directions on page 7-17.
- 4) If one or both of the fuses has blown, replace both fuses following the instructions beginning on page 7-17.

Chart 8

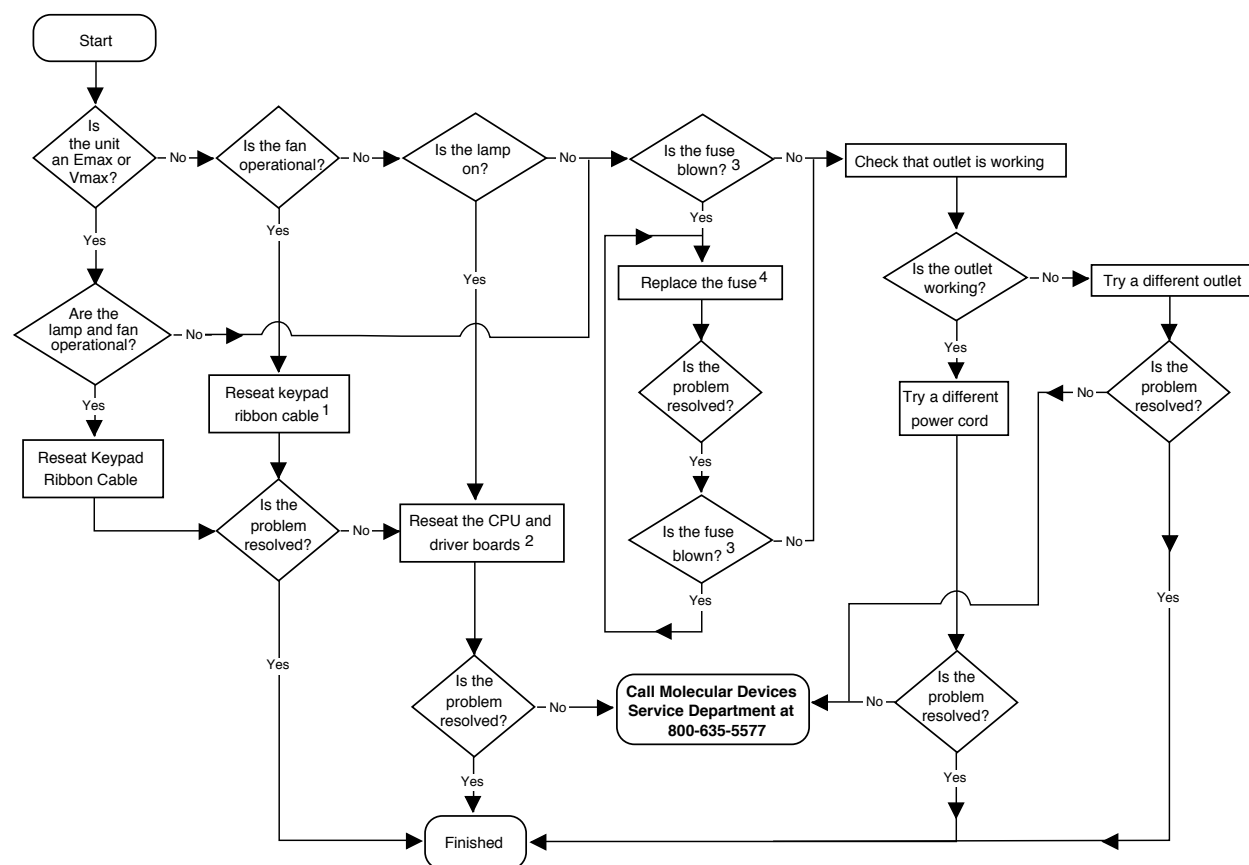


Chart 9: The fuse blows each time the instrument is turned on

This problem most often results from the use of incorrect fuses in the instrument, but it can be the result of a faulty electrical circuit or power surges/spikes.

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:

- 1) Open the fuse box cover and check the the fuses following the directions on page 7-17.
- 2) Replace both fuses following the instructions beginning on page 7-17.

Chart 9

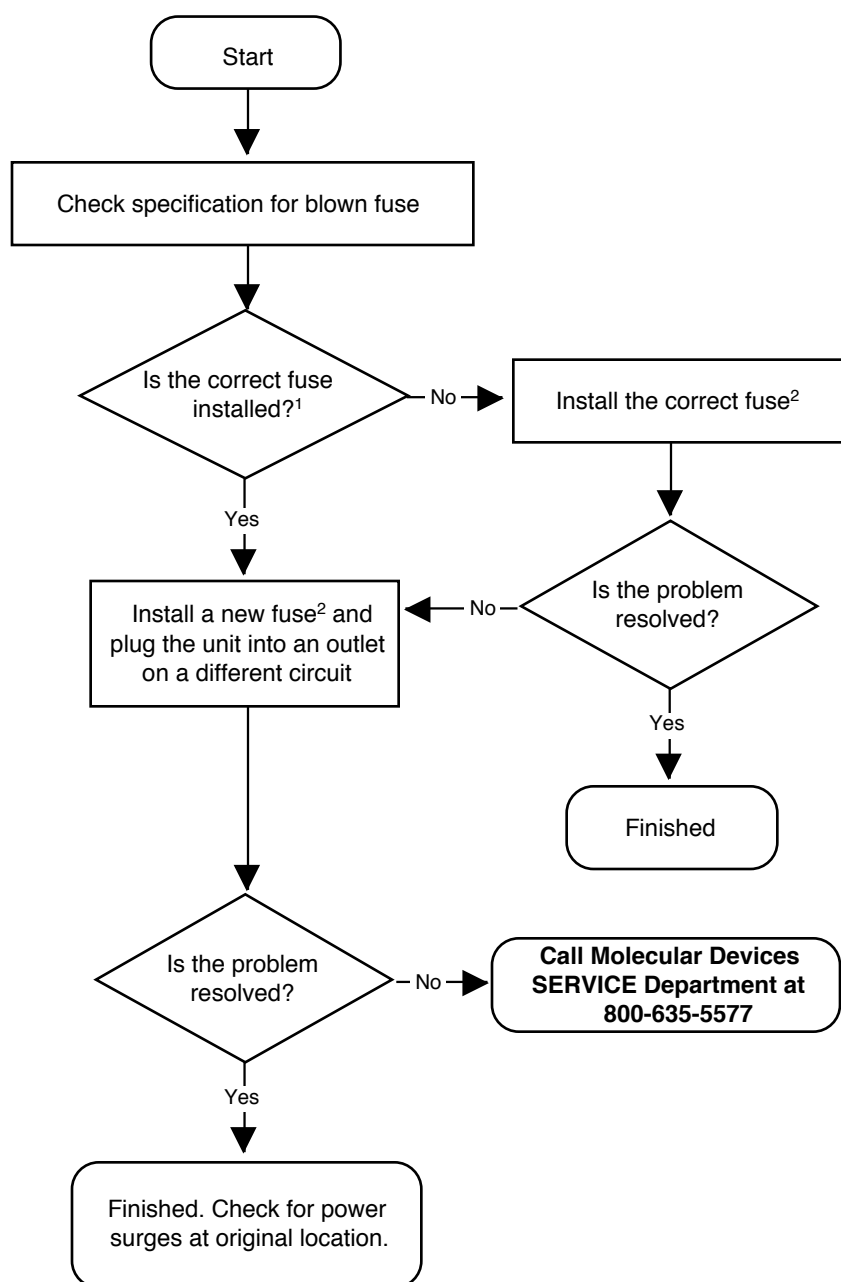



Chart 10: The instrument is making a loud, high pitched noise or pinging

This problem can be the result of dust or dirt buildup inside the instrument, a faulty lamp, or both.

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:

- 1) Follow the procedure for the air reference and kinetic noise tests beginning on page 8-42.
- 2) Follow the procedure for testing instrument reproducibility beginning on page 8-44.
- 3) Use a source of clean, dry air such as canned air to blow into the reading chamber and remove any dust buildup. **See caution, below.** To do this, manually open the drawer about halfway (or, if the drawer is open, close it halfway) and blow the air into the reading chamber.

 **CAUTION:** If using canned air, please note the cautions regarding freezing listed on the label of the product before proceeding with this step.

- 4) Follow the procedure for changing the lamp beginning on page 7-13.

Chart 10

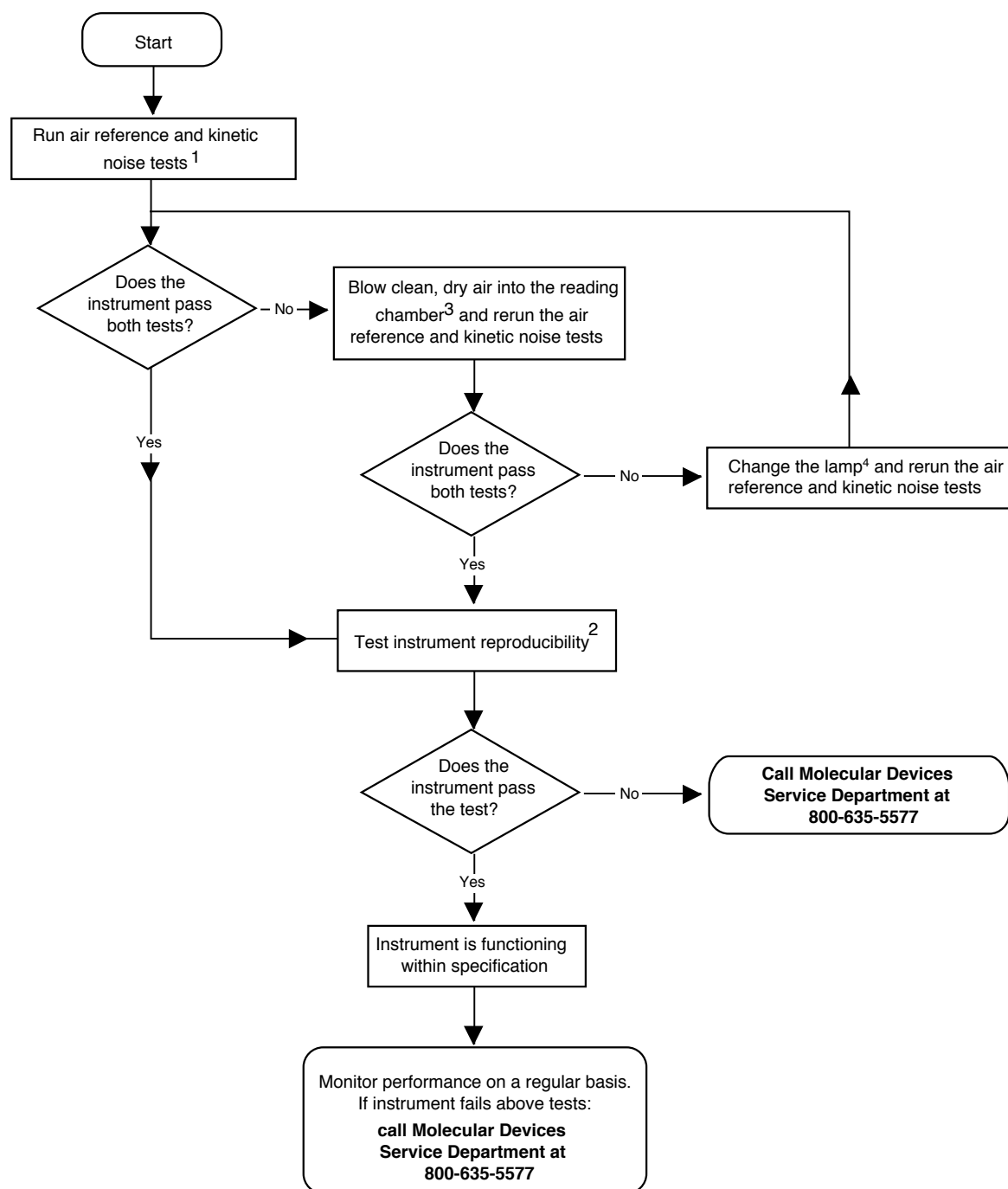


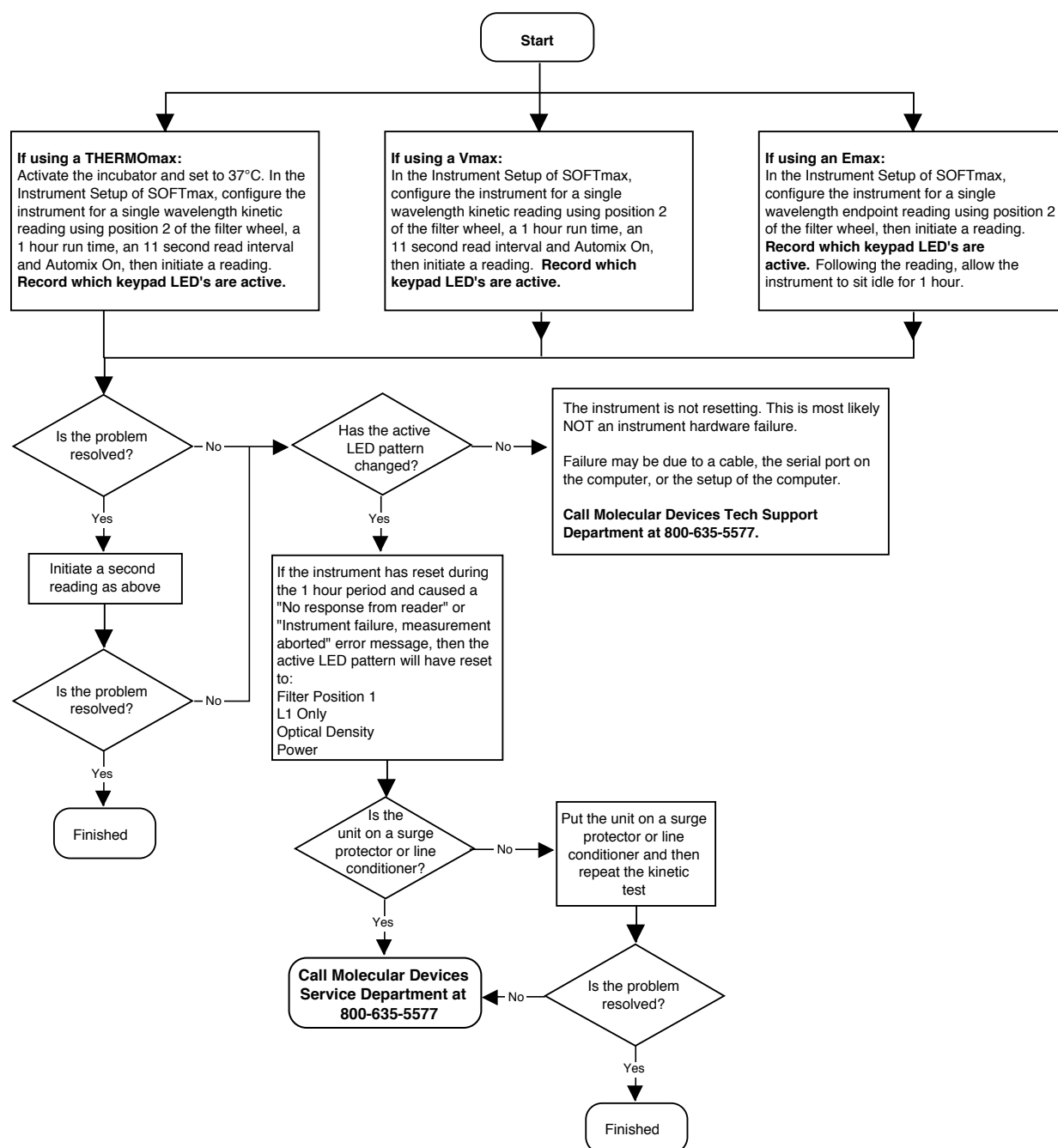
Chart 11: Timed Out Error—No response from reader

This problem occurs when communication between the reader and computer is terminated after initial communication (i.e., during a kinetic run or in between endpoint readings, or when trying to take an endpoint reading).

This problem can occur when the instrument resets due to a surge or spike from a power source, interference due to other computer communications signals (on a network, for example), the computer's serial port or cable might be faulty, or the instrument setup may be in error.

Follow the instructions in the chart on the opposite page to determine the source of the problem.

Chart 11



[Charts continue on next page]

Chart 12: Unable to establish communication with the reader when initially entering the software using a computer to control the instrument

This problem can occur for a number of reasons:

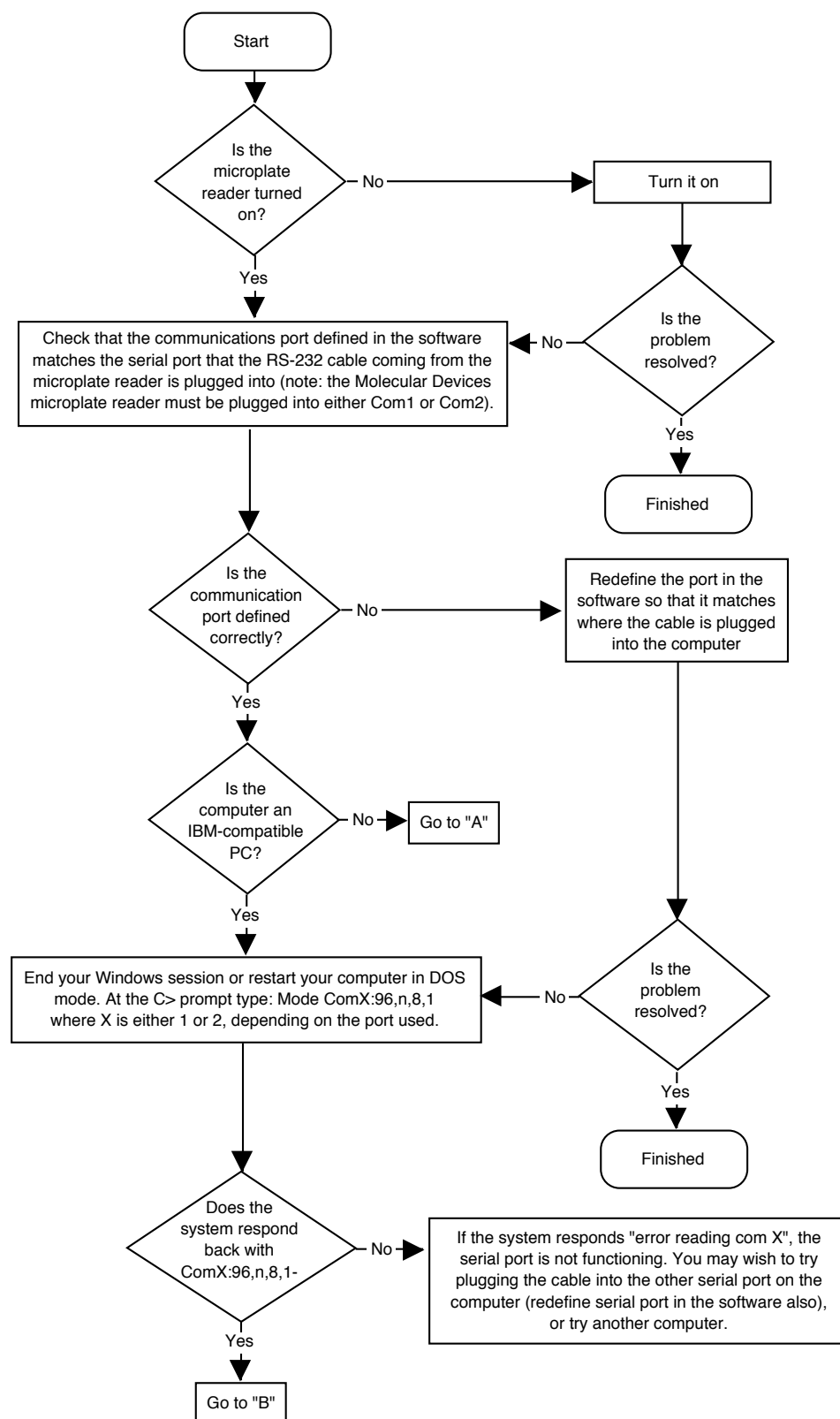
- The communication port defined in the software may not agree with the physical port connection for the serial cable from the reader to the computer
- The SOFTmax or SOFTmax PRO software may have become corrupted or a required file may be missing
- A conflict may exist between the software program and another device connected to the computer that is trying to use the same communications port
- The serial port may be malfunctioning
- The serial cable may have incorrect pinouts or may be bad
- A conflict between extensions (Macintosh) or interrupts (IRQ settings on the PC)
- If networked, the computer may be receiving conflicting signals from another computer

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart (following pages):

- 1) Check the actual pinouts of the cable against the specifications for cable pin connections starting on page 3-7. If determining the pinouts of the cable is not possible, a new cable may be ordered from Molecular Devices (see part numbers for ordering also on page 3-7).

Chart 12



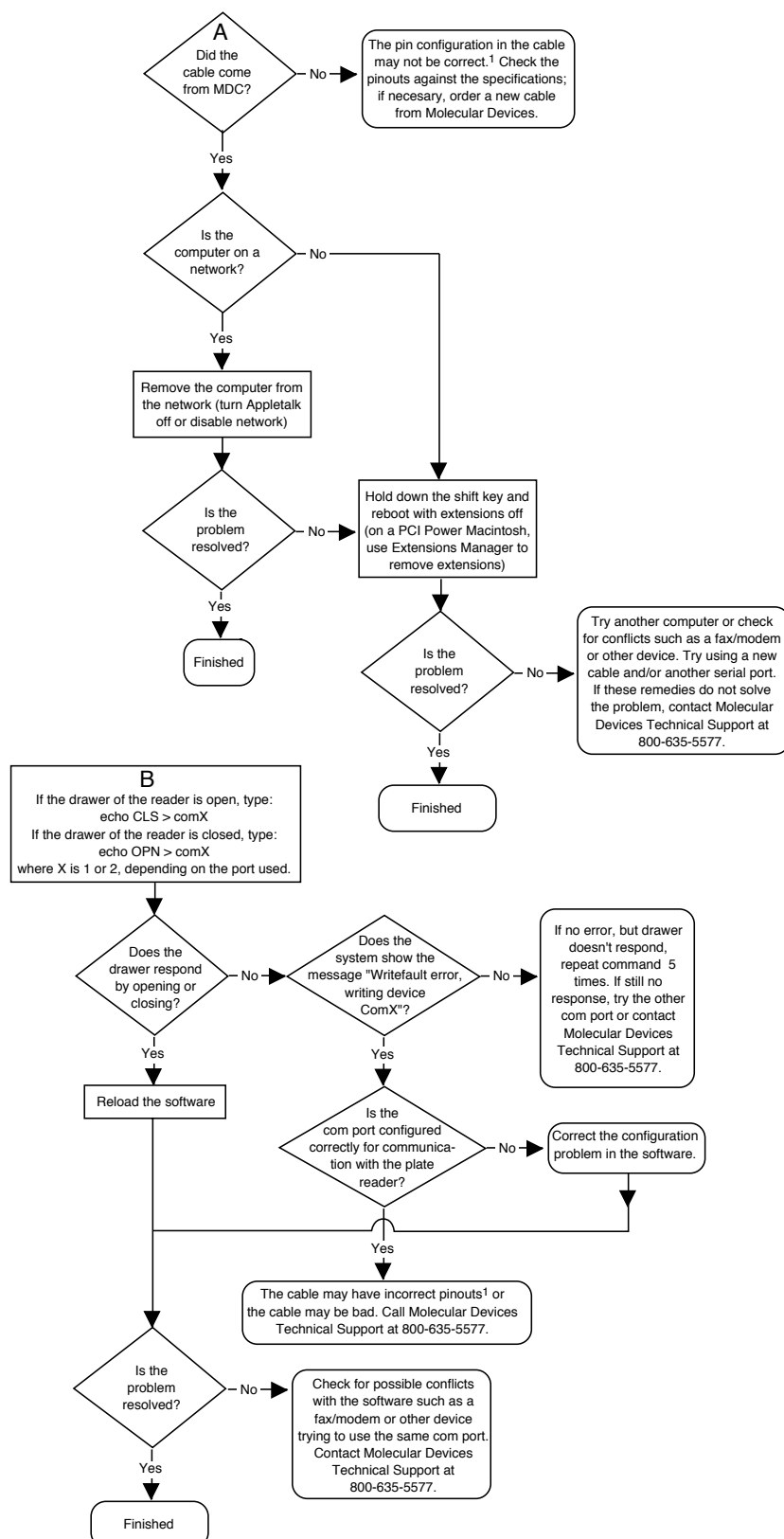


Chart 13: Abnormal OD readings in wells X, Y, Z; Endpoint ODs higher/lower than expected; Kinetic rates lower/higher than expected; Assay is lower/higher today than yesterday

This problem can occur for a number of reasons:

- The lamp is no longer functioning properly and needs changing
- Surges or spikes in power are causing variations in readings
- Dirt or dust may be causing the filters to function improperly

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:

- 1) Follow the instructions on page 7-13 to change the lamp.
- 2) Follow the procedure for the air reference and kinetic noise tests beginning on page 8-42.
- 3) Follow the procedure for testing instrument reproducibility beginning on page 8-44.
- 4) Use a source of clean, dry air such as canned air to blow into the reading chamber and remove any dust buildup. **See caution, below.** To do this, manually open the drawer about halfway (or, if the drawer is open, close it halfway) and blow the air into the reading chamber.


 **CAUTION:** If using canned air, please note the cautions regarding freezing listed on the label of the product before proceeding with this step.

Chart 13

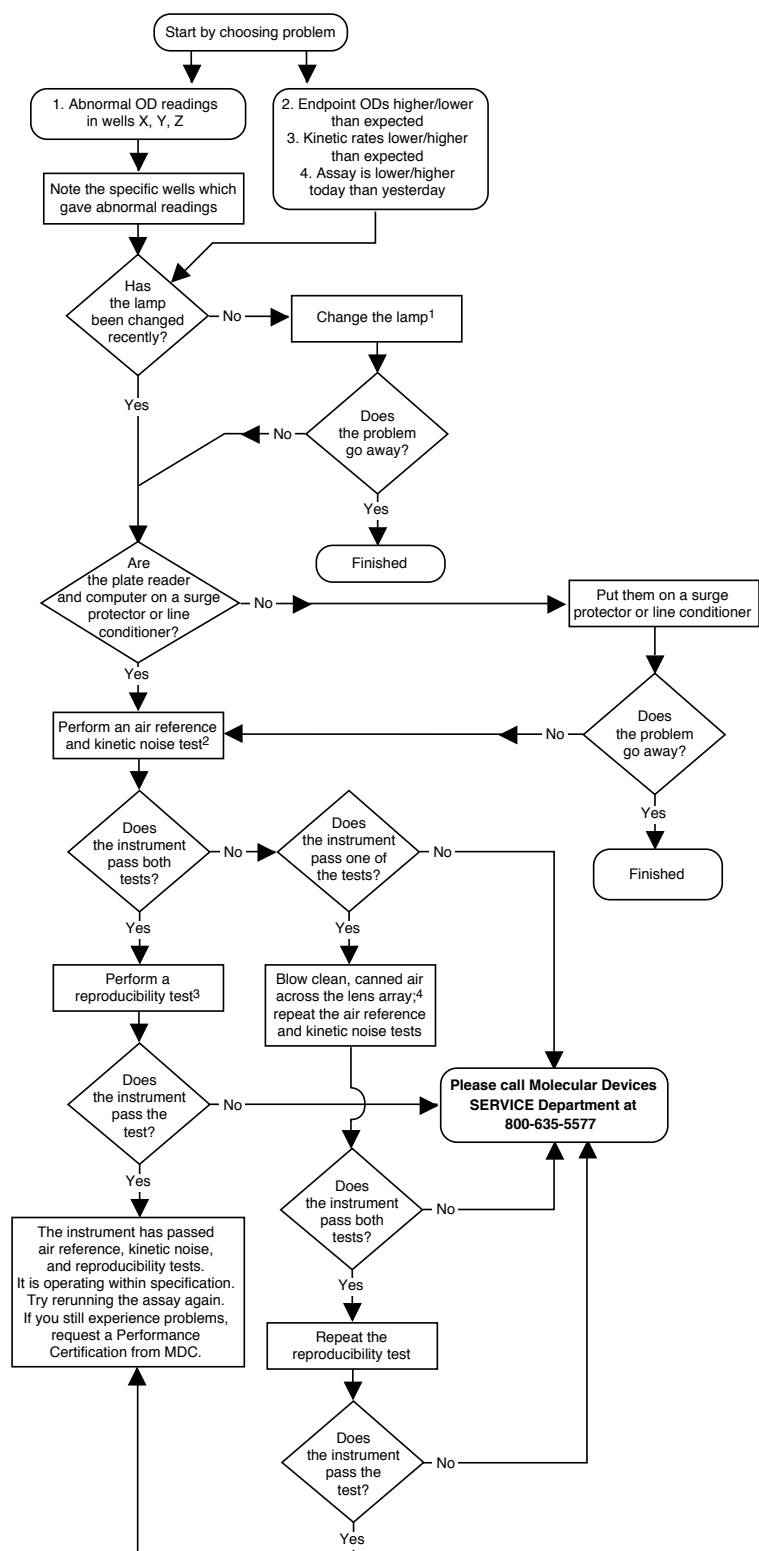


Chart 14: Noisy Kinetic readings

This problem can occur for a number of reasons:

- The lamp is no longer functioning properly and needs changing
- Bubbles are present in the wells
- Dirt or dust may be causing the filters to function improperly

Follow the instructions in the chart on the opposite page to determine the source of the problem. Footnote numbers in the chart refer to the notes given below.

Notes for the Chart, opposite:

- 1) Follow the instructions on page 7-13 to change the lamp.
- 2) Follow the procedure for the air reference and kinetic noise tests beginning on page 8-42.
- 3) Follow the procedure for testing instrument reproducibility beginning on page 8-44.
- 4) Use a source of clean, dry air such as canned air to blow into the reading chamber and remove any dust buildup. **See caution, below.** To do this, manually open the drawer about halfway (or, if the drawer is open, close it halfway) and blow the air into the reading chamber.


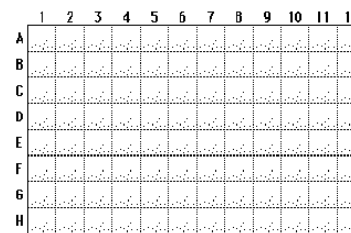
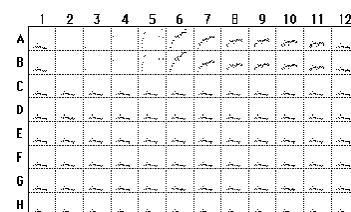
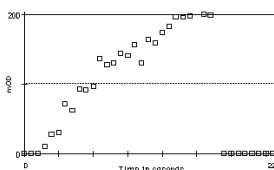
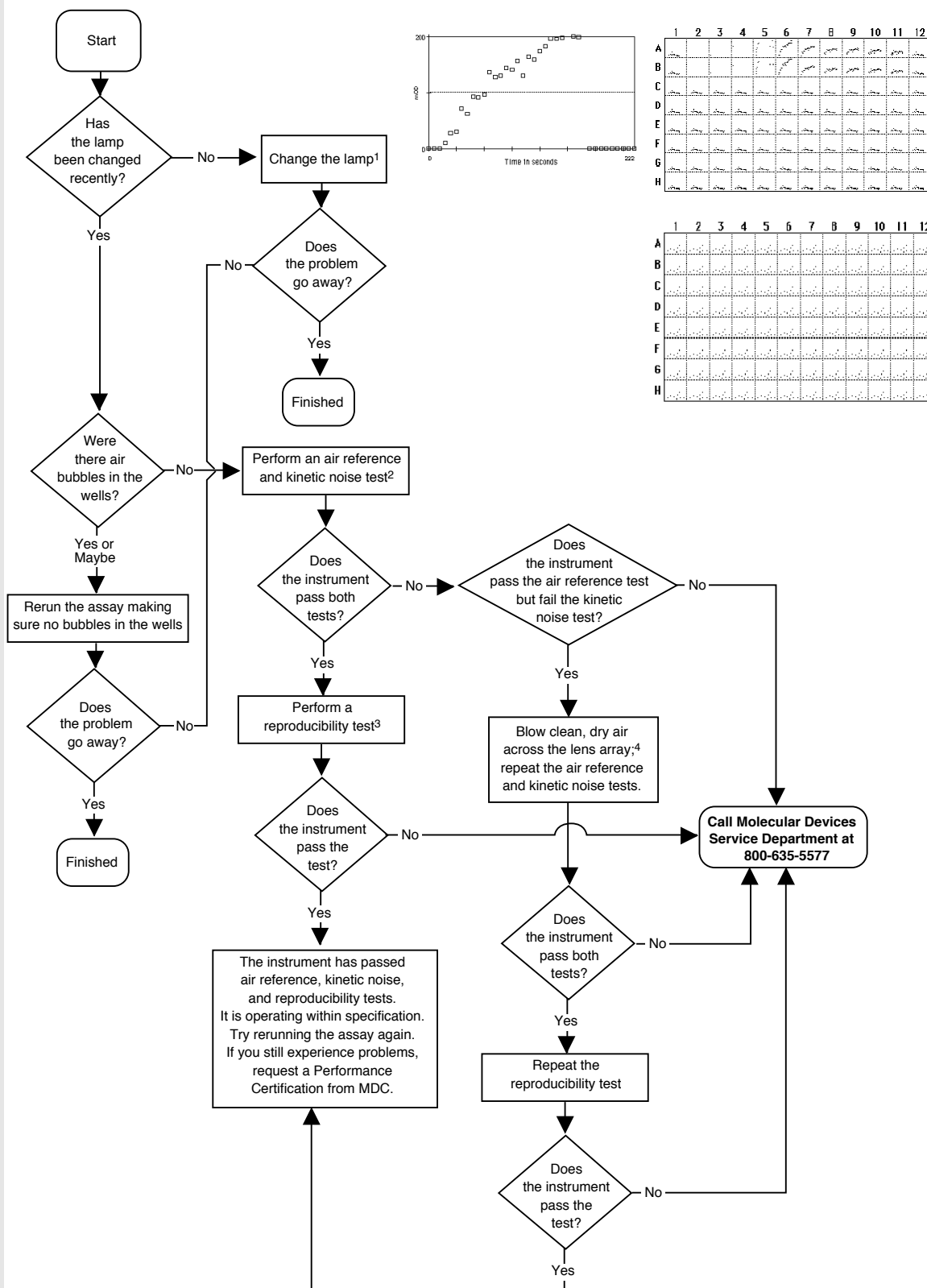
 **CAUTION:** If using canned air, please note the cautions regarding freezing listed on the label of the product before proceeding with this step.

Chart 14

V_{max}
T_{max}



Air Reference Test and Kinetic Noise Test

Introduction

The air reference test and kinetic noise test are diagnostic tools used to help assess the performance of the microplate reader. The lowest wavelength interference filter available provides the most rigorous test of the optics because the amount of light available from the lamp decreases as the wavelength decreases. Thus, should any degradation of the optics occur, performance will generally decline initially at lower wavelengths. After running these tests, if any numbers fall outside of the specifications given below please contact Molecular Devices Technical Support at 800-635-5577.

Air Reference Test

The air reference test is an endpoint test. Configure the instrument as follows:

Emax/Vmax	THERMOmax
Endpoint reading (L1)	Endpoint reading (L1)
Wavelength: 405 nm*	Wavelength: 340nm*
AUTOMix: On**	AUTOMix: On
* If 405nm (Emax/Vmax) or 340nm (THERMOmax) filters are not available, use the lowest wavelength available.	
** AUTOMix is not available on the Emax.	

Perform five (5) consecutive endpoint readings **WITHOUT** a microplate in the drawer. For each reading, all 96 values should be 0.000 ± 0.002 OD (between -0.002 and +0.002 OD). If there are any readings outside this range, the unit has failed the test.

NOTE: The above specification does NOT apply to the 550 nm 1-nm bandwidth filter.

Vmax
Tmax

Kinetic Noise Test

This test cannot be run on Emax instruments. Configure the Vmax and THERMOmax as follows:

Vmax	THERMOmax
Kinetic run (L1)	Kinetic run (L1)
Wavelength: 405	Wavelength: 340
Run time 5 minutes (5:00)	Run time 5 minutes (5:00)
Read interval 10sec* (0:10)	Read interval 10sec* (0:10)
AUTOmix: On	AUTOmix: On
* The read interval applies to those using SOFTmax software. In stand-alone mode the read interval is preset.	

Perform a single kinetic reading **WITHOUT** a microplate in the drawer. At the end of the reading, the rates should be 0.0 ± 0.20 mOD/min (between -0.20 and +0.20 mOD/min). When using SOFTmax software, use the total number of Vmax Points and Vmax Rate analysis. If there are any readings outside this range, the unit has failed the test.

NOTE: The above specification does NOT apply to the 550 nm 1-nm bandwidth filter.

Reproducibility Test

Introduction

The reproducibility test is a diagnostic tool used to help assess the performance of the MAXline Microplate Reader. After running this test, if any numbers fall outside of the specifications given below, please contact Molecular Devices Technical Support at 800-635-5577.

Chromophore

Use a chromophore that absorbs at the wavelength of interest. The chromophore should be stable over time (that is, the optical density of the solution should not change as a function of time during the reproducibility test). The chromophore should not form multimers at the concentration being used. The chromophore should be homogenous (not have particulates present).

- 1) Prepare a solution of chromophore with a concentration such that a volume of 200 μ l per well will give an OD between 1 and 2.
- 2) Pipet 200 μ l of the chromophore solution into all 96 wells of the microplate.

Reading the Plate

Read the Microplate five (5) times with well A1 in position A1 of the drawer. Then rotate the plate 180° (well A1 in position H12 of the drawer) and read the plate five (5) times. This is a total of 10 endpoint reads at the wavelength of interest. (This should be done at a single wavelength with autocalibrate on and AUTOMix off.)

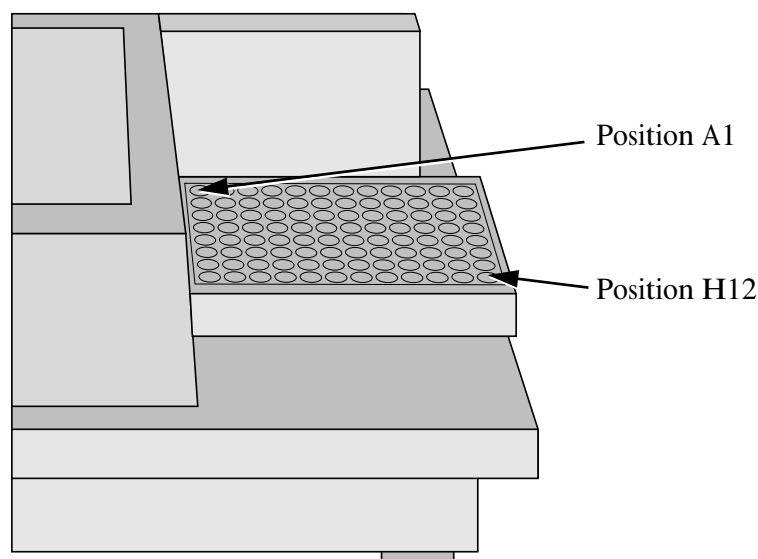


Figure 8.1: Positions A1 and H12 in the Drawer When Standing in Front of the Microplate Reader

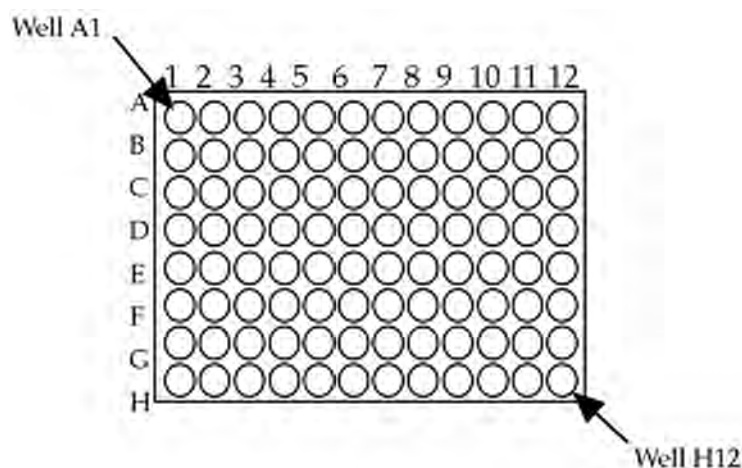


Figure 8.2: Well Positions in the 96-Well Microplate

Analyzing the Data

For a full reproducibility study, the data must be analyzed for all 96 wells. You may choose to do an initial analysis on a subset of wells. Using a spreadsheet such as Microsoft Excel can speed the analysis of the data.

- 1) Examine the data for a given well (for example, well A1 will have 5 readings when it was in position A1 of the drawer and 5 readings when it was in position H12 of the drawer). Does the optical density increase or decrease with time? If so, the study is invalid. The optical density should NOT change as a function of time.
- 2) Calculate Reproducibility:
 - A) Calculate the mean of the 10 readings for a given well (for example, well A1 will have 5 readings when it was in position A1 of the drawer and 5 readings when it was in position H12 of the drawer).
 - B) Calculate 1% of the mean.
 - C) Calculate the high and low limits (all 10 replicate readings should be between the high and low limits):

$$\text{Mean OD} \pm (1\% \text{ of the mean OD} + 0.005)$$
 - D) Repeat steps A through C for all 96 wells.

Sample Analysis

Below is a sample analysis done in an EXCEL spreadsheet:

	A	B	C	D	E	F
1		A1(h12)	A2(h11)	A3(h10)	A4(h9)	A5(h8)
2	plate 1,normal 1	0.257	0.139	0.289	0.284	0.433
3	plate 1,normal 2	0.257	0.137	0.288	0.285	0.433
4	plate 1,normal 3	0.258	0.135	0.289	0.285	0.433
5	plate 1,normal 4	0.258	0.131	0.288	0.285	0.432
6	plate 1,normal 5	0.258	0.132	0.289	0.284	0.432
7	plate 1,revrsl 1	0.256	0.152	0.283	0.285	0.462
8	plate 1,revrsl 2	0.256	0.151	0.283	0.286	0.463
9	plate 1,revrsl 3	0.255	0.151	0.282	0.285	0.462
10	plate 1,revrsl 4	0.255	0.152	0.283	0.286	0.462
11	plate 1,revrsl 5	0.255	0.152	0.283	0.287	0.463
12						
13	mean	0.257	0.143	0.286	0.285	0.448
14	1% of mean	0.003	0.001	0.003	0.003	0.004
15	mean +.005+1%	0.264	0.150	0.294	0.293	0.457
16	mean -.005-1%	0.249	0.137	0.278	0.277	0.438

Figure 8.3: Sample Analysis in Excel

If any of the 96 wells has data that is out of specification, please call Molecular Devices Technical Support at 800-635-5577.

Communication Problems

If a red X appears over the instrument icon in the upper left corner of SOFTmax PRO, or if the the reader status under the control menu in SOFTmax software says that the reader is offline, then a communication problem exists between the MAXline Microplate Reader and the computer.

First check to see that the correct communications port has been chosen in the software. If you are using SOFTmax PRO, go to the **Edit** menu and choose **Preferences**. Check to see that the communications port selected (modem or printer for a Macintosh computer or COM1 or COM2 for a PC) corresponds with the physical port on the computer to which the communications cable from the instrument is connected. If you are using SOFTmax software, go to the **Control** menu and choose **Reader Status**. Check to see that the correct communications port is highlighted (COM1 or COM2 for SOFTmax for Windows or the printer or modem port icons for SOFTmax for Macintosh). The setting under Reader Status should agree with the physical port to which the cable from the instrument is connected to the computer.

If the port setting is correct in the software, the microplate reader is on, and there is still no communication, turn the power off to both the computer and the microplate reader and check that the cable connections are secure.

If there is still no communication between the microplate reader and the computer, you may have an incorrect cable (see “Cable Connections” for your particular type of computer, below).

Other programs may also be interfering with communications. On a Macintosh, a quick check is to boot up the computer without extensions (on a 680xx computer, hold down the Shift key; on a Power PC, use the Extensions Manager to disable all but System files and reboot). If the computer is now able to communicate with the microplate reader, another program was interfering with communications. If you still do not have communications between the microplate reader and the computer, call Molecular Devices Technical Support. On a PC, check to see that no programs are loading at startup. If you still cannot communicate with the microplate reader when no other programs (other than Windows) are running, call Molecular Devices Technical Support.

Macintosh Cable Connections

For any MAXline Microplate Reader connected to a Macintosh, one end of the cable should end with an 8-pin DIN connector. This connector is small and round and should be connected to either the modem or printer port of the Macintosh.

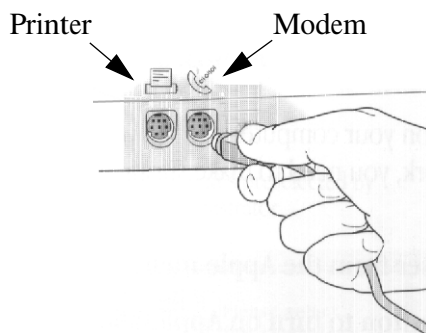


Figure 8.4: 8-Pin Din Connection to Macintosh Computer

For MAXline Microplate Readers connected to a PC, the end of the cable connecting to the instrument should end in a DB-25 connector (which is long and narrow and has 25 pins).

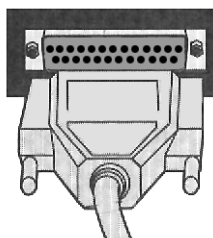


Figure 8.5: DB-25 Connection to MAXline Microplate Reader

Both types of cables should be double-shielded, straight-through serial cables. If you are unsure of the quality of the cable you are using, Molecular Devices suggests that you purchase a cable of known quality and try the connection again.

PC Cable Connections

The end of the cable that will attach to the MAXline Microplate Reader must be a DB-25 (25-pin) connector.

The connector required to connect to your PC will depend upon the type of serial port(s) available on your computer. Typically, at least one 9-pin or 25-pin serial port is available on a PC; most have two, which are known as COM1 and COM2, respectively. The connector for your computer may be a 9-pin or 25-pin connector (or you can use an adapter that converts from 9-pins to 25-pins—see Figure 8.6).

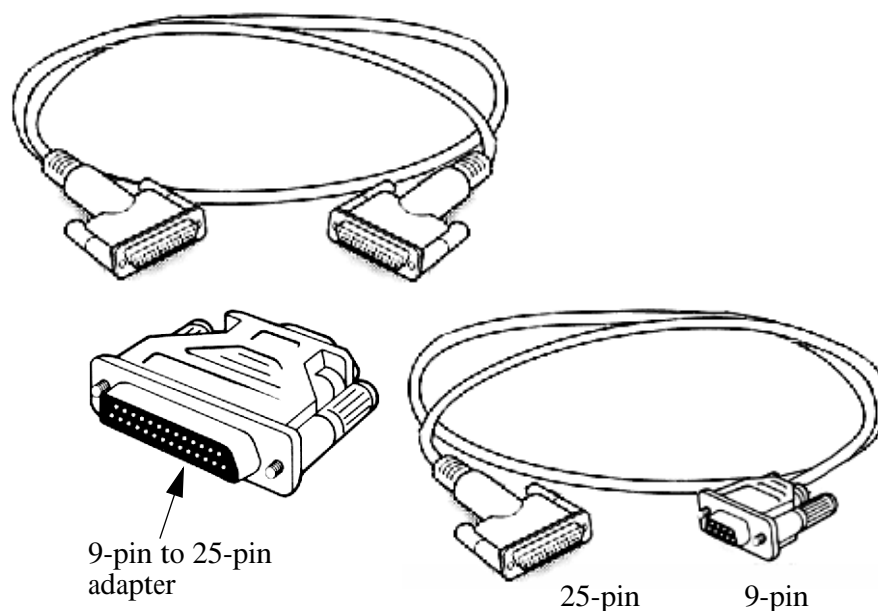


Figure 8.6: 25-Pin DIN to 25-Pin or 9-Pin Serial Cable

The cable itself should be a double-shielded, straight-through serial cable. If you are unsure of the quality of the cable you are using, Molecular Devices suggests that you purchase a cable of known quality and try the connection again.

Replacing the Microplate Drawer Springs

- 1) Turn off and unplug the instrument.
- 2) Remove the instrument top cover following the instructions located in Installing Optional Optical Filters on page 7-4.
- 3) If the unit is a THERMOmax, remove the thermal subplate from the drawer carriage (see instructions in Removing the Drawer Subplate on page 7-20).
- 4) To remove the drawer spring clip closest to the front of the unit, remove the two small Phillips screws retaining the spring clip. Access the screws through the two machined holes on the front side of the drawer carriage.
- 5) To access the remaining spring clip, the drawer carriage face must be removed from the right side of the drawer carriage. Remove the two small Phillips screws from the inside of the right side of the drawer carriage.
- 6) To remove the remaining spring clip, remove the two small Phillips screws on the right side of the drawer carriage.
- 7) Using the new spring clips, reverse the above procedure to complete the installation.


Cleaning an Optical Filter

All optical filters should be periodically cleaned depending upon the environment where the instrument is located. A yearly cleaning is usually sufficient.

- 1) Turn off and unplug the instrument.
- 2) Remove the instrument top cover and then remove the filter from the filter wheel following the instructions in Installing Optional Optical Filters on page 7-4.
- 3) Hold the filter by the edge or place it on a clean tissue.
- 4) Clean the filter first using a soft, lint-free tissue (such as a camera lens-cleaning tissue) or soft-tipped swab. If the filter requires further cleaning, dampen a lint-free tissue or swab with ethanol or methanol and clean the filter. **DO NOT SUBMERGE THE FILTER IN LIQUID.** Acetone is *not* recommended as a solvent for cleaning as it dries too quickly and leaves a residue.
- 5) Replace the filter in the filter wheel.
- 6) Replace the instrument top cover.

Disconnecting and Reconnect- ing the Keypad Ribbon Cable

- 1) TURN OFF AND UNPLUG THE INSTRUMENT. The instrument must be unplugged before proceeding any further.
- 2) Remove the instrument top cover following the instructions in Installing Optional Optical Filters on page 7-4.

 **CAUTION:** When you disconnect a cable, pull on its connector or on its strain-relief loop, not on the cable itself. As you pull connectors apart, keep them evenly aligned to avoid bending any connector pins. Also, before you connect a cable, make sure both connectors are correctly oriented and aligned.

- 3) A flat, gray ribbon cable connects the keypad PC board on the top cover to the CPU board. Disconnect the ribbon cable from the CPU board by pulling upward on the black connector at the driver board.
- 4) Reseat the black connector on the CPU board. Verify that both sets of pins are engaged as the cable is seated.
- 5) Disconnect the ribbon cable from the keypad PC board. The black connector should be removed by pulling it parallel to the keypad PC board.
- 6) Reseat the black connector on the keypad PC board. Verify that both sets of pins are engaged as the cable is seated.
- 7) Replace the instrument top cover.

Removing and Reinstalling the Driver and CPU Boards

- 1) TURN OFF AND UNPLUG THE INSTRUMENT. The instrument must be unplugged before proceeding any further.
- 2) Remove the instrument top cover following the instructions in Installing Optional Optical Filters on page 7-4.
 - ⚠ **CAUTION:** Touch an unpainted, metal surface on the chassis before touching any boards or other components inside the instrument. While you work, periodically touch an unpainted metal surface on the instrument chassis to dissipate any static electricity that might harm internal components.
 - ⚠ **CAUTION:** Handle computer boards (cards) with care. Don't touch the components or contacts on a card. Hold a card by its edges or by its metal mounting bracket.
- 3) Two vertical, green PC boards (cards) can be seen on the right side of the instrument. Both are connected to the motherboard. A flat, gray ribbon cable connects the keypad PC board on the top cover to the CPU board. The driver board is located directly behind the CPU board. Lift the CPU board from its connector by pulling directly upward.
- 4) Reseat the CPU board in its connector by pushing downward on the top of the board. The CPU board can only be installed in one direction. Do not twist the board during installation as this may cause damage to the board.
- 5) Lift the driver board from its connector by pulling directly upward. The driver board will remain connected to additional cables and cannot be completely removed from the instrument.
- 6) Reseat the driver board in its connector by pushing downward on the top of the board. The driver board can only be installed in one direction. Do not twist the board during installation as this may cause damage to the board.
- 7) Replace the instrument top cover.

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