THORLABS

MLS203-1
Fast XY Scanning Stage

User Guide

Original Instructions

Contents

Chapter 1 Overview

1.1 Introduction

The MLS203 uses internally integrated brushless DC servo motors with optical linear encoders to provide an industry-leading, high-speed, compact scanning stage for microscopy. This innovative design eliminates the external motor housings that create mechanical clash points and impede access to the sample. It is ideal as a drop-in upgrade replacement for the stage on Olympus IX71/IX81, Nikon TE2000/Eclipse Ti Series inverted microscopes, and Olympus BX51/BX61, Nikon 80i/90i Series upright microscopes.

The scanning stage can be positioned with a resolution of 0.1 µm and repeatability of 0.25 µm, at speeds up to 250 mm/s. The high-quality construction uses high-rigidity precision linear bearings, commercial grade limit switches, and powerful brushless linear DC servo motors. In addition, the number of moving parts has been minimized, which optimizes the lifetime and reliability of the scanning stage.

Accessory plates are available for the stage to allow the positioning of standard microscope slides and petri dishes, well plates and custom sample holders.

The MLS203 stages should be driven by the BBD series of brushless DC motor controllers. These controllers include the Thorlabs apt software suite, which provides an easy-to-use graphical interface for stand-alone operation as well as programming support for integrated applications. The controller can also be used with most third party software packages.

Fig. 1.1 MLS203 stage with MLS203P1 well plate adapter and 96 hole well plate, mounted on a microscope

Chapter 2 Safety

2.1 Safety Information

For the continuing safety of the operators of this equipment, and the protection of the equipment itself, the operator should take note of the **Warnings, Cautions** and **Notes** throughout this handbook and, where visible, on the product itself.

The following safety symbols may be used throughout the handbook and on the equipment itself.

Warning: Risk of Electrical Shock

Given when there is a risk of injury from electrical shock.

Warning

Given when there is a risk of injury to users.

Caution

Given when there is a risk of damage to the product.

Note

Clarification of an instruction or additional information.

2.2 General Warnings

Warning

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. In particular, excessive moisture may impair operation.

Spillage of fluid, such as sample solutions, should be avoided. If spillage does occur, clean up immediately using absorbant tissue. Do not allow spilled fluid to enter the internal mechanism.

Chapter 3 Installation

3.1 Unpacking

Caution

Once removed from its packaging, the stage can be easily damaged by mishandling. The unit should only be handled by its base, not by any attachments to the moving platform.‘

Note

Retain the packing in which the unit was shipped, for use in future transportation.

3.2 Mounting

3.2.1 General

Caution

The performance of the stage could be affected if the mounting surface is not flat to within 200µm. Care should be taken when bolting the stage to the microscope to ensure that the base plate does not warp, which could cause stiffness to be experienced in the bearing rails. The attachment brackets for mounting the stage to a particular microscope are supplied with shims, which should be fitted as necessary - for more details see the instructions for fitting the attachment brackets.

When mounting the stage close to other equipment, ensure that the travel of the moving platform is not obstructed. If equipment mounted on the moving platform is driven against a solid object, damage to the internal mechanism could occur. The range of travel is as follows:

X-axis 110mm (4.3"), Y-axis 75mm (2.95”).

When considering the stage movement in the proximity of other objects or equipment, ensure that movement of cables connected to the moving carriage is not impeded.

When mounting equipment to the moving platform, always use the fixings supplied with the equipment being fitted. If these are not available, do not use fixings that protrude more than 2.5 mm below the bottom surface of the equipment being mounted as this could damage the internal mechanism of the stage.

Damaging the stage in this way could invalidate the warranty.

3.2.2 Fitting the Finger Guards

The stages are supplied with finger guards to avoid trapping of body parts or cables in the mechanism. These should be fitted before the stage is mounted on the microscope as follows:

1) Offer up the finger guards to the stage as shown below, and secure using the M3 x 16 bolts supplied.

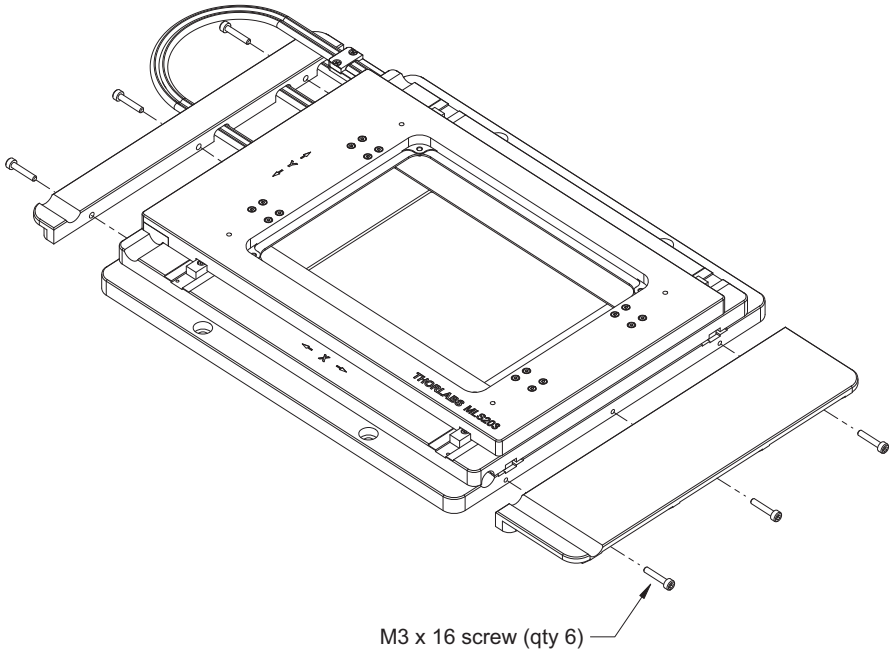


Fig. 3.1 Fitting the finger guards

3.2.3 Mounting To Microscope

The stage can be mounted to select inverted and upright microscopes from Olympus and Nikon using mounting brackets which are purchased separately. Details on mounting the stage to a particular microscope are contained in the fitting instructions for the brackets.

3.3 Electrical Connections

The stage must be driven by a Thorlabs BBD series controller. Connect the motor leads to the MOTOR DRIVE connectors, and the encoder feedback leads to the FEEDBACK connectors. Ensure that the motor drive and feedback leads for each motor are connected to the correct channel.

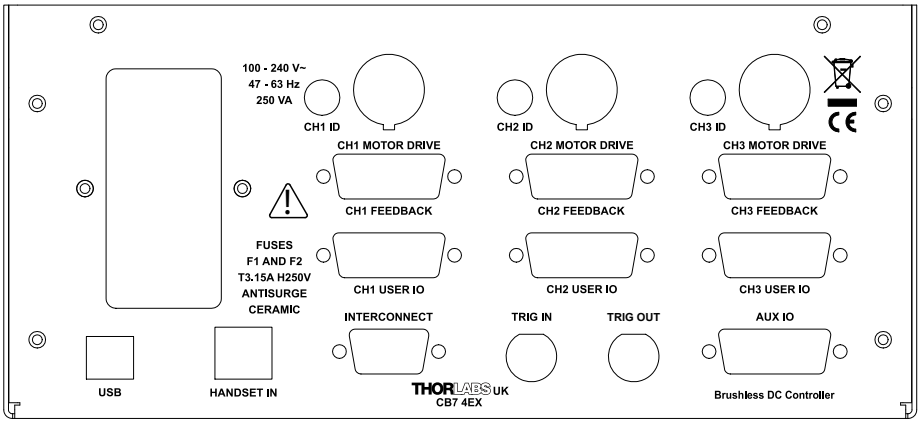
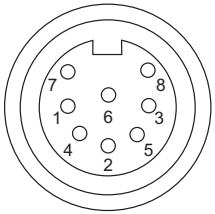


Fig. 3.2 Electrical connections

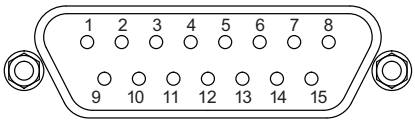
Pin out information for the motor drive and encoder feedback connectors on the motor flying leads is detailed below.

MOTOR DRIVE



1	Motor Phase V	5	Stage ID
2	GND	6	GND
3	Thermistor (not used)	7	Motor Phase W
4	Motor Phase U	8	Enable

ENCODER FEEDBACK



1		9	GND
2	GND	10	Limit Switch +
3		11	Limit Switch -
4	Enc Index -	12	Enc Index +
5	QB -	13	QB +
6	QA -	14	QA +
7	5 V	15	x
8	5 V		

Fig. 3.3 Motor Drive and Feedback Flying Lead Pin Out Details

3.4 Dimensions

3.4.1 MLS203-1 Dimensions

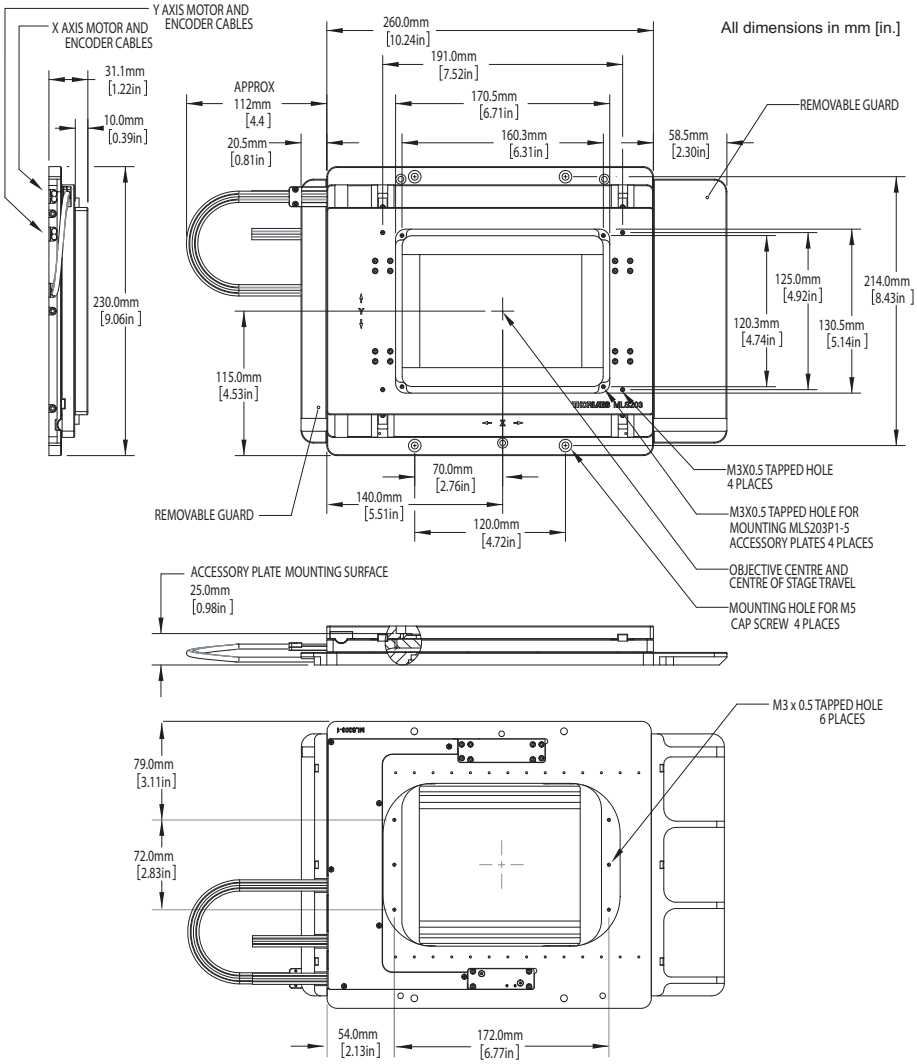


Fig. 3.4 MLS203-1 Dimensions

Chapter 4 Operation

4.1 General

Caution

The MLS203 stages is designed to be driven by the Thorlabs BBD20x or RBD201 Brushless DC Motor Controllers.

The stages are connected to the controller via 2 flying leads terminated in D-type connectors (FEEDBACK) and 2 leads terminated in round 8-Pin DIN Connectors (MOTOR DRIVE).

Warning

The motor controller must be switched OFF before the stages are plugged in or unplugged. Failure to switch the controller off may result in damage to either the controller, the stage, or both.

For a complete tutorial on using the stage, see the manual supplied with the controller. Basic steps in controlling the stage are as follows:

1) Make electrical connections as detailed in Section 3.3.
2) Move the moving platform a few times over its full range of travel to overcome any storage resistance, then position the moving platform to be around its central position.

Warning

3-phase brushless DC motors are commutated electronically, i.e. the controller drives the coils with a precisely controlled waveform, that depends on the position of the rotor (or, with linear motors, the position of the coil housing). On power up, the position of the coil housing is not known. The controller establishes this by energising the coils and measuring the resulting movement. This is why on power up, the stage (motor) may make a slight buzzing noise and move about randomly for a few seconds. Phase initialization can only take place if the motor can move unobstructed during this time. Before powering up the BBD controller at item (2), ensure that the stage movement is unobstructed.

3) Power up the controller and wait for 10 secs until the Channel Enable LEDs start flashing.
4) If a joystick control is being used, press and hold the ‘High/Low’ button for 2 seconds, then release to home the stage. When homing is complete, the green LED stops flashing.
5) If no joystick is being used, click the Home button on the GUI panel.

4.2 Using the Kinesis software

The stage is shipped already loaded with default parameter settings, which should give satisfactory performance in most cases. However, depending on the application, it may be necessary to adjust the PID loop parameter settings to fine tune the response - see the following section for more information.

1) If it is not already running, start the Kinesis software - Start/Programs/Thorlabs/Kinesis/Kinesis
   The software reads in the stage and controller information on boot up and the GUI panel shown below is displayed..

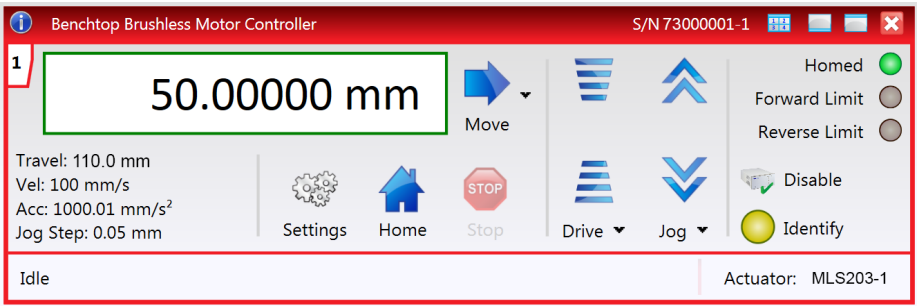


Fig. 4.1 Kinesis GUI screen

Note

The MOTOR DRIVE connectors for each channel/axis contain an EEPROM, which stores the factory default settings for the set up parameters. When the stage is connected, these settings are loaded into the controller on start up, and are tuned for loads up to the 1.0 kg (2.2 lb) maximum, at speeds up to 250 mm/s.

However, depending on the load being driven and the speed/duty cycle of the particular application, it may be necessary to further optimize the Position PID loop settings.

If problems are encountered (e.g. stability of the closed loop position control, lost motion or incomplete moves) the position loop PID parameters should be adjusted to tune the stage for the given application. Normally, only minor adjustment of the Proportional, Integral and Derivative parameters should be necessary, and some trial and error will be required before the ideal settings for a specific application are achieved. In cases where further adjustment of the control loop parameters is required, the following guidelines are provided in order to assist in the tuning process.

2) Click the Settings button on the GUI to display the Settings panel, then select the 'Advanced' tab.

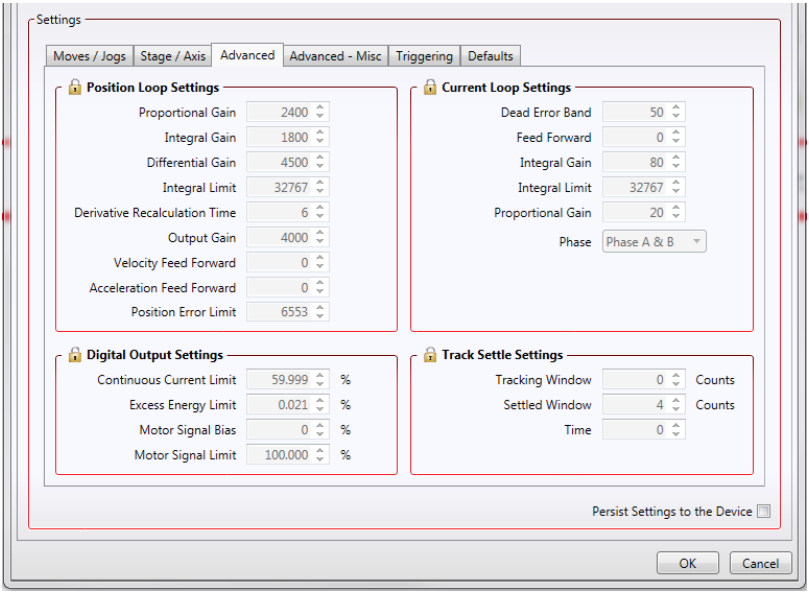


Fig. 4.2 Advanced Control Loop Settings

3) Create a Custom Settings Group (see the Kinesis helpfile for more information) and then adjust the acceleration and PID settings to fine tune the control loop for your application - see Table 4.1 and Table 4.2 for more information.
4) After the parameter changes have been performed, click the 'Persist Settings to Hardware' box, then click 'OK'. This will ensure that the same parameter settings will be loaded next time the unit is powered up - even in the absence of a PC.

Table 4.1 Position Loop Parameter Adjustment Guidelines

Load Range(g)	Derivative	Derivative Time	Output Gain
0 to 250	4500	5	4000
250 to 500	5160	5	4660
500 to 750	5830	6	5330
750 to 900	6500	7	6000

Depending on the shape of the mass and the accelerations and velocities used the values quoted above may require adjustment to provide optimum performance.

Table 4.2 Load vs Maximum acceleration recommendations

Load (g)	Approximate Max Acceleration (mm/s²)
0	5000
125	2400
250	1550
500	925
750	650
900	500

The values quoted above are the maximum values recommended to avoid over current errors. These values are a guideline only, and depending on the shape of the mass and the velocities used, these values may require further adjustment, particularly if the stages are mounted in an XY configuration.

Note

Position PID Settings Summary

Stage overshoots the intended position - reduce the integral term, and increase the derivative and proportional terms.

Stage fails to attain final position - increase the integral and proportional terms.

Motion is unstable - reduce the proportional and integral terms, increase the derivative term.

Stage sounds noisy - reduce the derivative term.

Please see the handbook supplied with the controller, for more information on changing these settings

4.3 Using the APT software

The stage is shipped already loaded with default parameter settings, which should give satisfactory performance in most cases. However, depending on the application, it may be necessary to adjust the PID loop parameter settings to fine tune the response - see the following section for more information.

1) If it is not already running, start the APTUser utility - Start/Programs/Thorlabs/APT User/APT User
   The APT server reads in the stage and controller information on boot up and the GUI panel shown below is displayed..

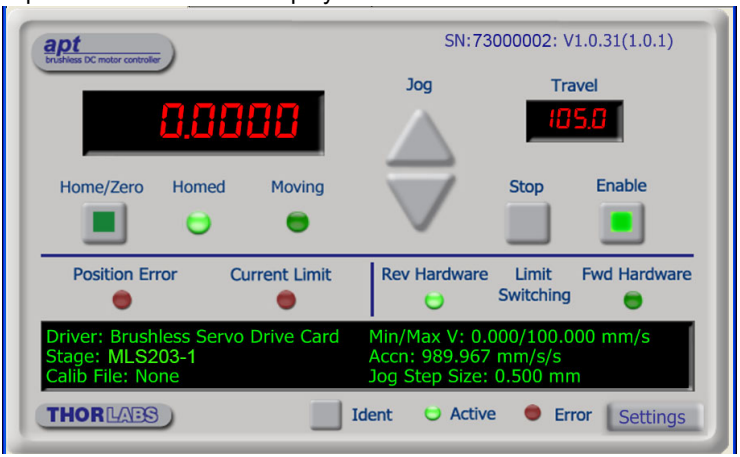


Fig. 4.3 APTUser GUI screen

Note

The MOTOR DRIVE connectors for each channel/axis contain an EEPROM, which stores the factory default settings for the set up parameters. When the stage is connected, these settings are loaded into the controller on start up, and are tuned for loads up to the 1.0 kg (2.2 lb) maximum, at speeds up to 250 mm/s.

However, depending on the load being driven and the speed/duty cycle of the particular application, it may be necessary to further optimize the Position PID loop settings.

If problems are encountered (e.g. stability of the closed loop position control, lost motion or incomplete moves) the position loop PID parameters should be adjusted to tune the stage for the given application. Normally, only minor adjustment of the Proportional, Integral and Derivative parameters should be necessary, and some trial and error will be required before the ideal settings for a specific application are achieved. In cases where further adjustment of the control loop parameters is required, the following guidelines are provided in order to assist in the tuning process.

2) Click the Settings button on the GUI to display the Settings panel, then select the 'Advanced' tab.

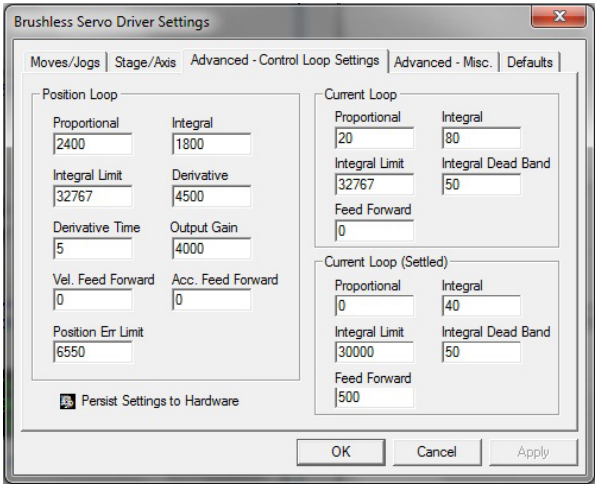


Fig. 4.4 Advanced Control Loop Settings

3) Adjust the acceleration and PID settings to fine tune the control loop for your application see Table 4.1 and Table 4.2 for more information.
4) After the parameter changes have been performed, click the 'Persist Settings to Hardware' box, then click 'OK'. This will ensure that the same parameter settings will be loaded next time the unit is powered up - even in the absence of a PC.

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The values quoted above are the maximum values recommended to avoid over current errors. These values are a guideline only, and depending on the shape of the mass and the velocities used, these values may require further adjustment, particularly if the stages are mounted in an XY configuration.

4.4 Position Error Messages.

Caution

The maximum velocity at which the encoder can operate is approximately 400 mm/sec. Above this speed, encoder pulses may be lost and, as a result, the position readout becomes incorrect. This renders normal operation impossible because phase commutation of the motor is also based on the encoder reading.

When the stage is controlled by the BBD20x controller, the maximum velocity is limited to safe values. However, if the output is disabled (with the controller connected and monitoring the position) and the stage is moved manually at high speeds, it is possible to exceed this limit. If the BBD20x controller is subsequently used again to move the stage, the incorrect encoder reading will cause incorrect operation, often resulting in sudden uncontrolled moves. It is therefore important not to move the stage excessively quickly when it is moved manually.

The BBD controller has fault monitoring to detect the loss of encoder pulses. If this fault occurs, an error message will be generated and the controller must be powered down and re-started so that correct phasing and commutation can be established.

If this fault occurs when the stage is being controlled via the MJC001 joystick, in the absence of a PC, the red LED on the joystick console is lit, and all operation is suspended until the controller is shut down and rebooted.

4.5 Transportation

Caution

When packing the unit for shipping, use the original packing. If this is not available, use a strong box and surround the unit with at least 100 mm of shock absorbent material.

4.6 Maintenance

The product is maintenance free. If any problems occur, the user should contact the local Thorlabs tech support for more information.

4.7 Transportation

Caution

When packing the unit for shipping, use the original packing. If this is not available, use a strong box and surround the unit with at least 100 mm of shock absorbent material.

Chapter 5 Specification

Parameter	Value
Travel	110 mm x 75 mm (4.3" x 2.95")
Max Speed	250 mm/s*
Acceleration	2000 mm/s*
Bidirectional Repeatability	0.25 µm
Unidirectional Repeatability	0.25 µm
Backlash	N/A (No Leadscrew)
Min Incremental Movement	0.1 µm
Home Location Accuracy	0.25 µm
Max Load	2.2 lbs (1 kg)

Note

Depending on the application, heavy loads may affect the stage performance and/or stability.

Absolute On-Axis Accuracy	<3 µm
Max Percentage Accuracy	X-Axis (110 mm) 0.0027% Y-Axis (75 mm) 0.004%
Settling Time within 1 µm (600 g load)*	0.1 sec
Settling Time within 0.1 µm (600 g load) *	0.6 sec
Limit Switches	X and Y as Standard
Bearing Type	High Rigidity Recirculating Precision Linear Bearing
Motor Type	Brushless DC Linear Motor
Dimensions (Mid Travel)	10.24 x 9.06" x 1.22" (260.0 mm x 230.0 mm x 31.1 mm)
Weight (with cables)	7.0 lbs (3.2 kg)

Note

The default tuning parameters can be changed to optimise settling times for a specific load.

Caution

The maximum speed and acceleration values quoted can be safely achieved with the maximum load and a high duty cycle. However in this case, some heating of the stage may occur and dimensional stability of the stage may be affected. This could result in less than optimal repeatability and accuracy. For cases were repeatability and accuracy are critical it is recommended that the stage temperature is allowed to reach a steady state before measurements are taken.

Alternatively the load, acceleration and duty cycle should be reduced from the maximum values. Some trial and error in setting these values may be necessary before the ideal settings are attained.

Chapter 6 Spares and Accessories

6.1 Parts List

We offer a number of options for mounting your biological samples to your stage. The MLS203P series of microscope sample platforms has been designed to provide flexible options of sample types: traditional slides, petri dishes or well plates, as well as uniquely shaped sample holders for biofilms, microfluidic studies and live sample viewing.

A range of attachment brackets is also available, which allow the stage to be fitted to specific microscopes from Nikon and Olympus - see www.thorlabs.com for more details.

Chapter 7 Regulatory

7.1 Declarations Of Conformity

7.1.1 For Customers in Europe

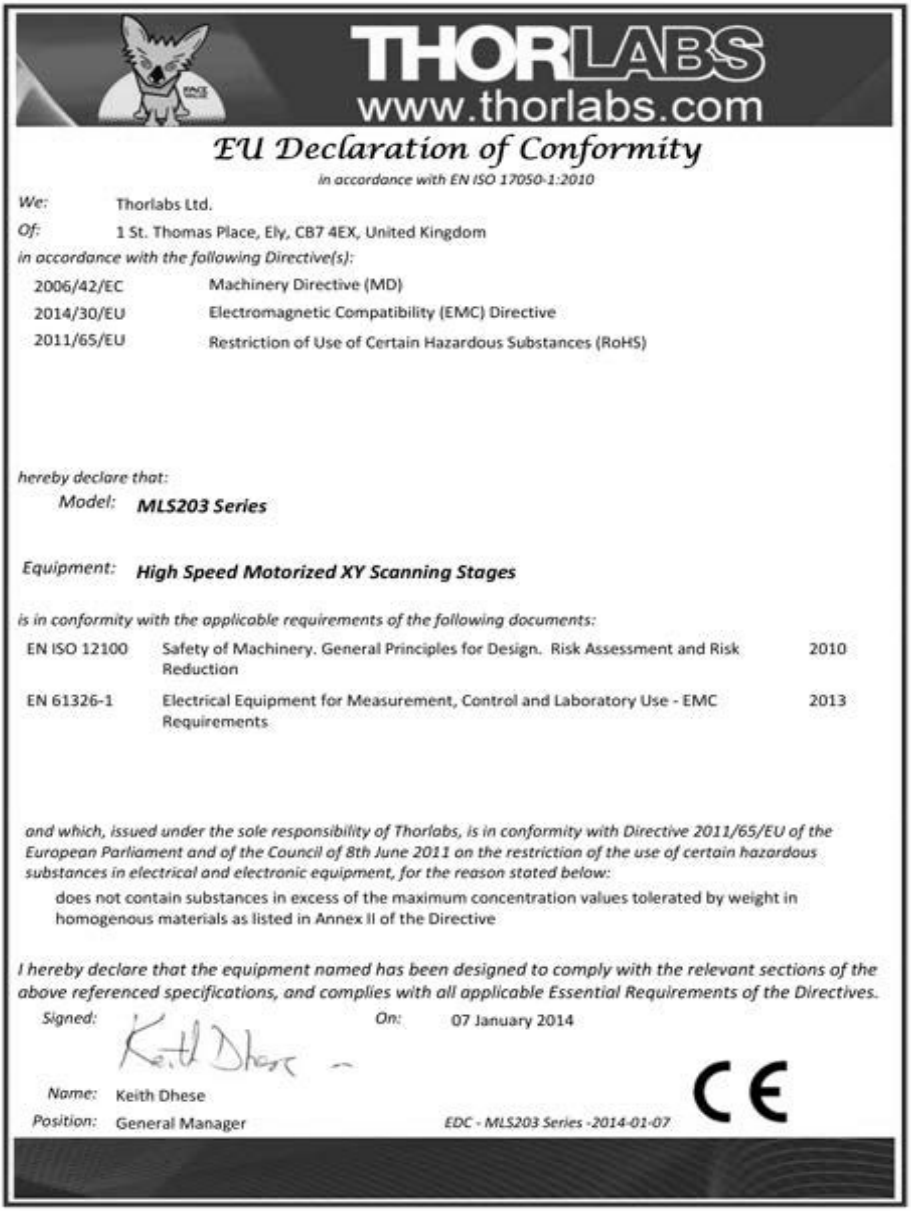
See Section 7.2.

7.1.2 For Customers In The USA

This equipment has been tested and found to comply with the limits for a Class A digital device, persuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by the company could void the user's authority to operate the equipment.

7.2 CE Certificates



THORLABS
www.thorlabs.com

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Ltd.

Of: 1 St. Thomas Place, Ely, CB7 4EX, United Kingdom

in accordance with the following Directive(s):

2006/42/EC	Machinery Directive (MD)
2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: ***MLS203 Series***

Equipment: ***High Speed Motorized XY Scanning Stages***

is in conformity with the applicable requirements of the following documents:

EN ISO 12100	Safety of Machinery. General Principles for Design. Risk Assessment and Risk Reduction	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013

and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:

does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed: *On:* 07 January 2014

Name: Keith Dhese

Position: General Manager

EDC - MLS203 Series -2014-01-07

CE

Chapter 8 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.

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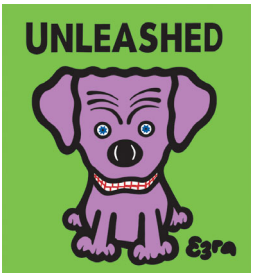
sales@thorlabs.jp

China
Thorlabs China
chinasales@thorlabs.com

Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return "end of life" Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out "wheelie bin" logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. "End of life" units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.



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