



# MAX300 Series NanoMax 3-Axis Flexure Stage

## User Guide



Original Instructions

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# Chapter 1 Overview

## 1.1 Description of the NanoMax 3-Axis Flexure Stage

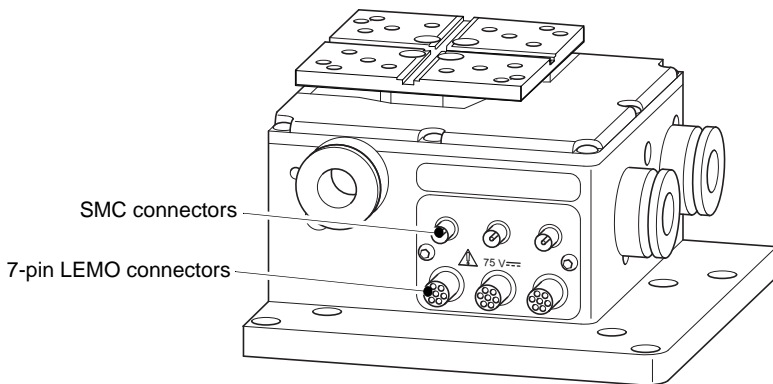
The NanoMax 3-axis flexure stage has been designed to integrate seamlessly into the Thorlabs Modular Electronic System and provide nanometric positioning on three orthogonal axes. It is suited to the alignment of optical fibres, waveguides, optoelectronic packages and any other high resolution alignment or positioning application including general purpose laboratory tasks. The innovative flexure design, combined with the system of modular drives, offers exceptional performance and flexibility.

Three types of drive are available, the DRV208 stepper motor drive, the DRV3 differential micrometer and the DRV004 thumbscrew. An external piezo actuator is also available which increases the piezo travel to 40  $\mu\text{m}$ .

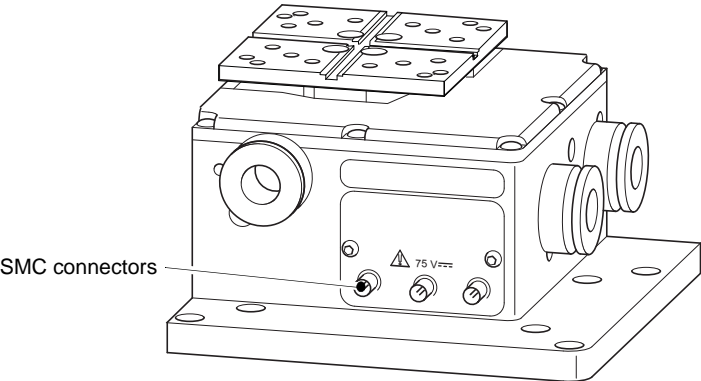
## 1.2 Component Identification

### 1.2.1 NanoMax Stage

The NanoMax 3-axis flexure stage is available in three versions; piezo-actuated with feedback on all axes, piezo-actuated without feedback and without piezo actuation, as shown in Fig. 1.1 to Fig. 1.4.



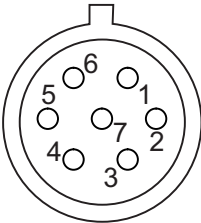
**Fig. 1.1 MAX301 NanoMax piezo-actuated stage with feedback on all axes**



**Fig. 1.2 MAX302 NanoMax piezo-actuated stage without feedback**

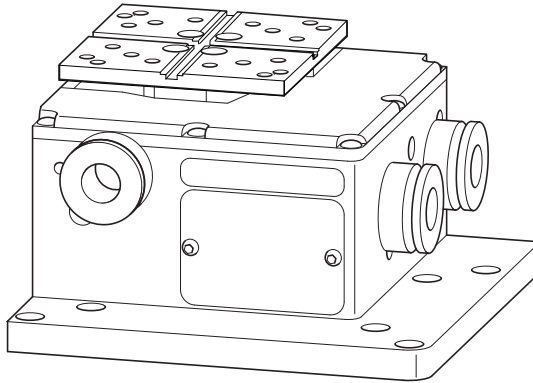
The piezo-actuated models deliver 20 microns of travel, each piezo channel has a coaxial SMC connector (see Fig. 1.1 and Fig. 1.2). In addition, the MAX301 has a 7-pin LEMO connector for each feedback channel (see Fig. 1.1). A corresponding number of leads for connection to the Thorlabs piezoelectric controllers are also supplied. The piezo-actuated models deliver 20 microns of travel, with a coaxial SMC connector for each piezo channel.

The pin functions for the Lemo connector are detailed below.



Pin	Description
1	+15 V
2	Oscillator +
3	0 V
4	Sig Out -
5	Sig Out +
6	-15 V
7	Travel

**Fig. 1.3 Feedback Lemo connector pin functions**

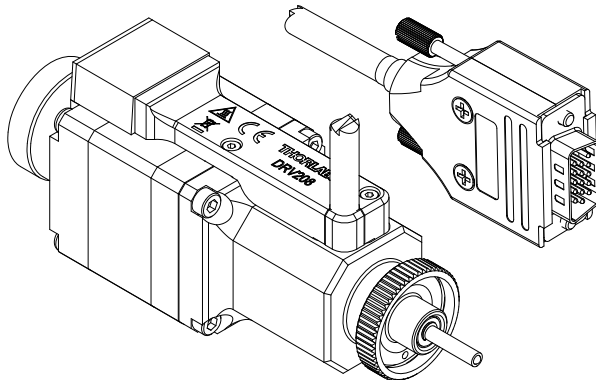


**Fig. 1.4 MAX303 NanoMax without piezo-actuation**

The MAX303 has no electrical connections.

### 1.2.2 Drives and Actuators

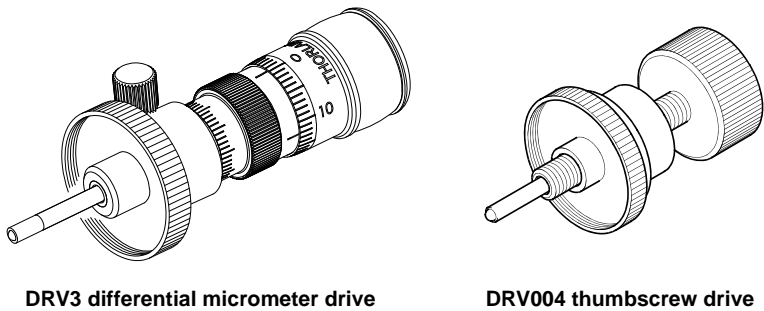
There are three types of drive available for the NanoMax, a motorized drive as shown in Fig. 1.5. and two manual drives as shown in Fig. 1.6. In addition, external piezo actuators are available to give an additional 20  $\mu\text{m}$  piezo travel – see Fig. 1.7.



#### **Note**

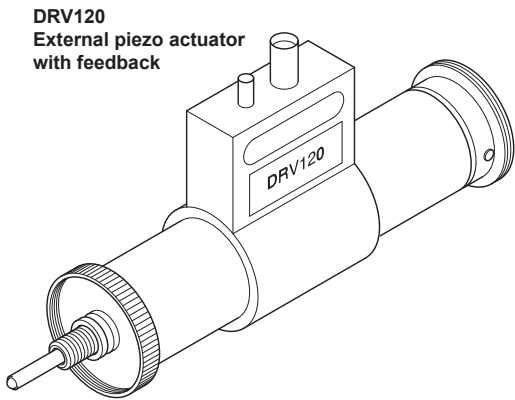
The DRV208 stepper motor drive should be used in conjunction with the BSC20x series benchtop driver or the MST602 control module.

**Fig. 1.5 DRV208 stepper motor drive**



**Fig. 1.6 Manual Drives**

The external piezo actuator can be fitted in-line with the standard drives described on the previous page. The DRV120 provides an additional 20  $\mu\text{m}$  of piezo travel.



**Fig. 1.7 Compatible Piezo Actuators**

## 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: Risk of Electrical Shock**

The piezo actuators in this product use high voltages and up to 75V may be present at the SMC connectors. This is hazardous and can cause serious injury. Appropriate care should be taken when using this device.

Persons using the device must understand the hazards associated with using high voltages and the steps necessary to avoid risk of electrical shock.

**Warning**

If the device is used in a manner not specified by Thorlabs, the protective features provided by the product 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.

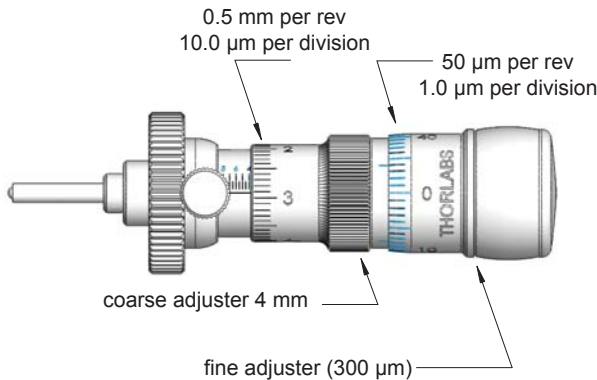
## Chapter 3 Operation

### 3.1 Manual Differential Drives and Differential Micrometer Drives

#### 3.1.1 Adjusting Micrometer Drives

Turn the coarse adjustment clockwise until the platform of the NanoMax begins to move. By use of the fine adjustment, sub-micron resolution is now achievable.

#### 3.1.2 Reading Micrometer Drives



**Fig. 3.1 Reading micrometer drives**

### 3.2 Stepper Motor Drives

To ensure that a particular stage is driven properly by the system, a number of parameters must first be set. These parameters relate to the physical characteristics of the stage being driven (e.g. min and max positions, leadscrew pitch, homing direction etc.).

To assist in setting these parameters correctly, it is possible to associate a specific stage type and axis with the motor controller channel. Once this association has been made, the server applies automatically, suitable default parameter values on boot up of the software.

#### **Note**

To ensure correct operation, it is important to select the correct stage and axis type as described above. Selecting an incompatible stage/axis type could result in reduced velocity and/or resolution, and in the worst case could cause the motor to run into the end stops or home incorrectly.



## Using Kinesis Software



### Caution

The host PC must be running Kinesis v1.14.12 or higher.

- 1) Ensure that the device is connected to the PC and powered up.
- 2) Run the Kinesis software - Start/All Programs/Thorlabs/Kinesis/Kinesis.
- 3) On start-up, the 'Actuator/Startup Settings' window is displayed. This window allows the correct actuator to be selected.

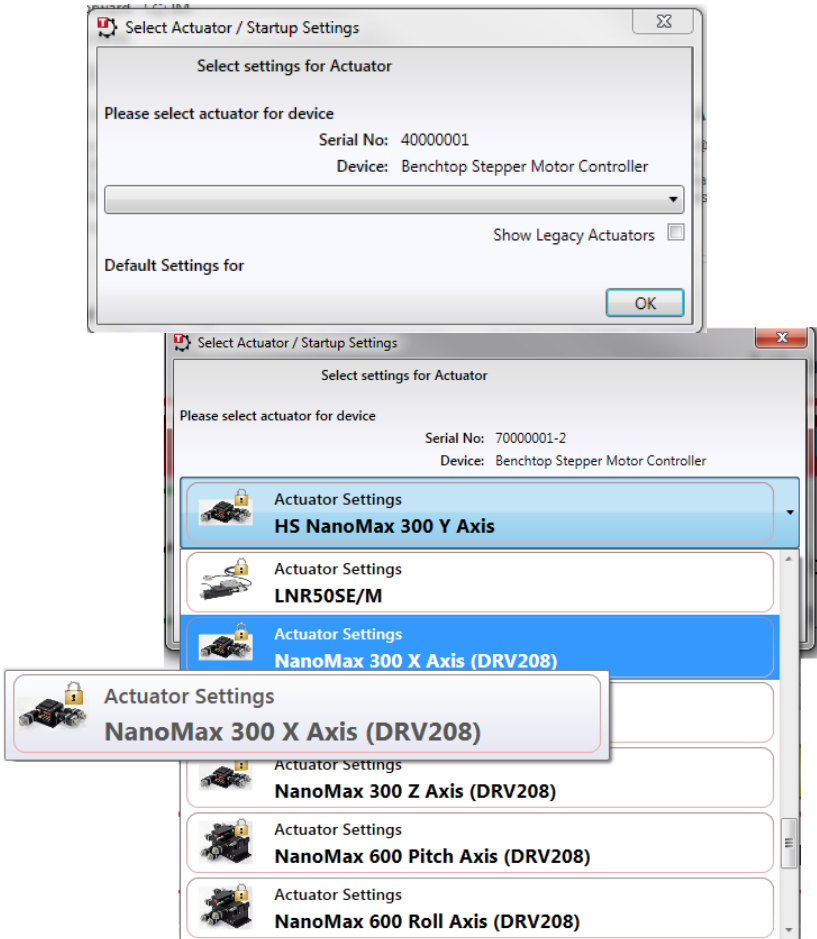


Fig. 3.2 Stage Configuration Window

- 4) Select your stage type (e.g. NanoMax 300 X-Axis (DRV208) if you have a NanoMax stage fitted with DRV208 actuators on the X-axis) as shown in Fig. 3.2.
- 5) Click OK.
- 6) The server reads in the stage and controller information automatically.  
Refer to the handbook for the associated controller for more information on driving the actuator/stage.

**Note**

These stepper motor drives have no forward limit switch and the travel is limited dependent on the axis to which it is attached. When the DRV208 motors are used with our Nanomax series stages, suitable defaults are loaded at start up to prevent the motor being overdriven. If the axis is driven towards the reverse limit switch, at a certain position the platform stops moving while the drive itself continues to move until the limit switch is reached. The drive must then be moved positively by a certain distance before the platform begins to move. This distance is just less than the offset.

When fitted to other stages or third party optomech products, it is possible that the motor will reach the mechanical hardstops of the stage before the travel limits of the actuator. In this case, consideration should be given to creating custom travel limit settings - see the handbook for the associated motor controller for more information.

When creating a program to control the actuator, it is recommended to avoid running into the mechanical hard stops.

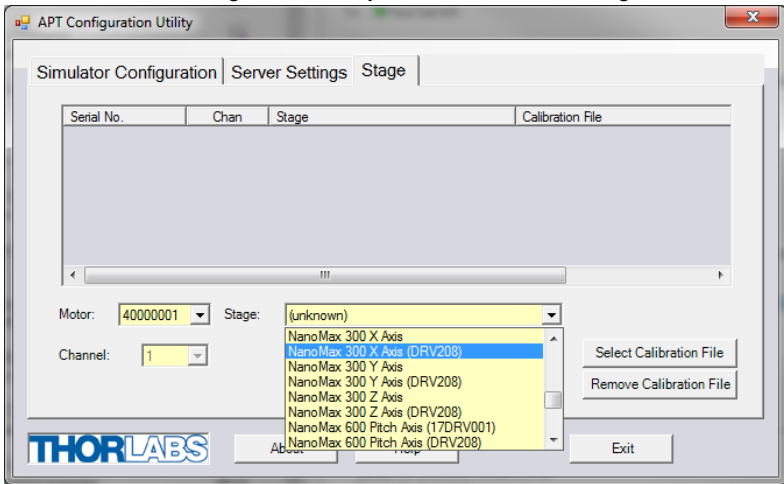
## Using APT Software



### Caution

The host PC must be running APT v3.21.3 or higher.

- 1) Shut down all applications using the APT server (e.g. APT User or your own custom application).
- 2) Run the APT Config utility - Start/All Programs/Thorlabs/APT Config/APT Config.
- 3) From the 'APT Configuration Utility' window, click the 'Stage' tab.



**Fig. 3.3 APT Configuration Utility - Stage Tab**

- 4) In the 'Motor' field, select the serial number of the stepper motor controller to be configured (this number can be found on the rear panel of the controller unit).
- 5) In the 'Stage' field, select your actuator type from the list displayed (e.g. NanoMax 300 X Axis (DRV208)), as shown in Fig. 3.3.
- 6) Click the 'Add Stage Association' button.
- 7) A default configuration is set at the factory and stored in the non-volatile memory of the motor controller. The server reads in the stage and controller information on

start up. Refer to the handbook for the associated controller for more information on driving the actuator/stage.

**Note**

These stepper motor drives have no forward limit switch and the travel is limited dependent on the axis to which it is attached. When the DRV208 motors are used with our Nanomax series stages, suitable defaults are loaded at start up to prevent the motor being overdriven. If the axis is driven towards the reverse limit switch, at a certain position the platform stops moving while the drive itself continues to move until the limit switch is reached. The drive must then be moved positively by a certain distance before the platform begins to move. This distance is just less than the offset.

When fitted to other stages or third party optomech products, it is possible that the motor will reach the mechanical hardstops of the stage before the travel limits of the actuator. In this case, consideration should be given to creating custom travel limit settings - see the handbook for the associated motor controller for more information.

When creating a program to control the actuator, it is recommended to avoid running into the mechanical hard stops.

### 3.3 Piezo Actuators

**Warning**

The piezo actuators in this product use high voltages and up to 75V may be present at the SMC connectors. This is hazardous and can cause serious injury. Appropriate care should be taken when using this device.

Persons using the device must understand the hazards associated with using high voltages and the steps necessary to avoid risk of electrical shock.

Piezo actuators are used to give nanometric positioning of the top platform over a range of 20 microns (40  $\mu\text{m}$  or 100  $\mu\text{m}$  if external piezo actuators are used). They can also modulate the position of the platform at high frequency.

On a piezo-actuated NanoMax, position feedback may be incorporated on the linear axes to enhance the repeatability and linearity of piezo motion.

The piezo-actuated NanoMax should be used together with one of the Thorlabs piezoelectric controllers – see the handbook for the relevant piezoelectric controller.

The NanoMax monitors the ambient temperature using thermistors and applies small movements to the stage to compensate for the expansion and contraction of metals within the stage. Note that this compensation is active only when the associated piezo controller is set to 'closed loop' (feedback on) mode – see the *relevant piezo controller handbook* for more details on the operation of piezo actuators.

**Caution**

Under normal operation, the piezo mechanism uses contact with the micrometer drives in order to move the top platform. If for any reason the stage is operated with the micrometer drives removed, blanking plugs must be fitted before the piezo actuators can function.

## Chapter 4 Installation

### 4.1 Unpacking

#### Note

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



#### Caution

Once removed from its packaging, the NanoMax is easily damaged by mishandling. The unit should only be handled by its base, not by the top platform or any attachments to the top platform.

### 4.2 Attaching to a Work Surface

The base of the NanoMax is provided with a number of fixing holes and slots for attachment to metric or inch optical tables, as supplied by Thorlabs and other manufacturers.

When mounting the NanoMax close to other equipment, ensure that the travel of the moving platform is not obstructed. If the moving platform is driven against a solid object, damage to the internal flexures could occur. The range of travel on each axis is 4 mm total, that is  $\pm 2$  mm about the nominal position.

### 4.3 Fitting and Removal of Drives

The following procedure details how to fit a drive to the NanoMax 300 stage. A micrometer drive is shown for illustration purposes but the procedure is equally applicable to motor or thumbscrew actuators.

- 1) For manual drives, rotate the coarse adjuster *counter-clockwise* a few turns to retract the drive rod. For motor drives, retract the drive rod by turning the manual adjuster *clockwise*.

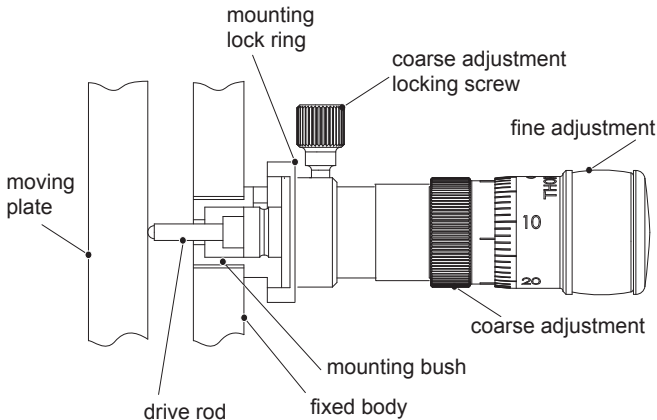
Then, referring to Fig. 4.1 on the next page...

- 2) Insert the drive into the mounting bush.
- 3) Tighten the knurled locking ring until finger tight.

**Note**

To remove a drive reverse the above procedure.

When removing a motor drive, rotate only the locking ring, do not rotate the motor body.



**Fig. 4.1 Micrometer drive inserted into mounting bush**

### 4.4 Orienting the Moving Platform

The stage is normally oriented such that the X axis is the optical axis. If it is necessary to change the orientation for left or right-handed use, the Y axis becomes the optical axis as shown in Fig. 4.2 (The Z axis is always vertical).

**Note.** On both imperial and metric models, the top platform is secured to the stage using four M3 screws.

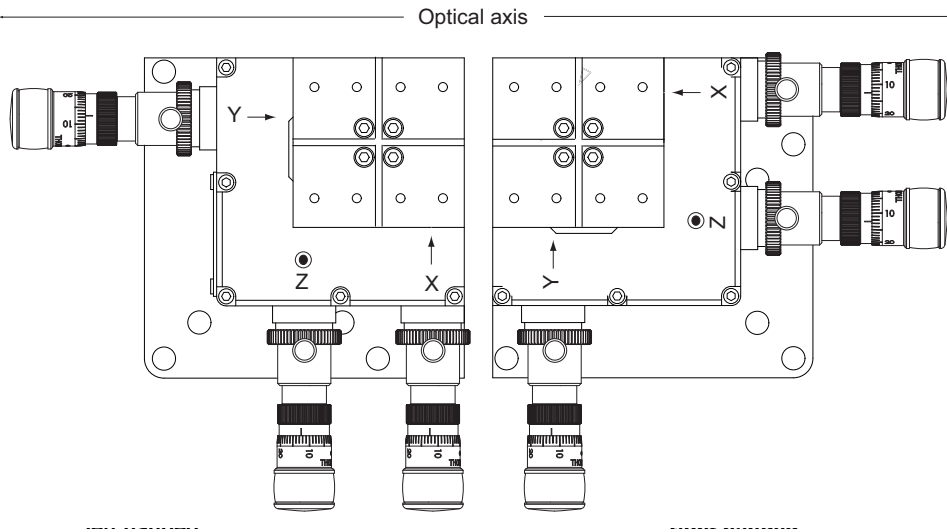


Fig. 4.2 Platform orientation



## 4.5 Mounting Equipment



### Caution

The internal mechanism of the unit is delicate and is easily damaged by mishandling.

Do not apply excessive forces to the moving platform.

When attaching accessories (e.g. fiber holders) to the top platform or angle brackets (e.g. AMA007 and AMA009) to the side of the unit, do not use long bolts which protrude into the internal mechanism as this could cause damage to the internal flexures.

The weight attached to the moving platform must not exceed 1 kg.

Thorlabs manufactures a variety of fibre chucks, holders and fixtures to fit the NanoMax stage. However, custom hardware can be designed using a tongue-in-groove arrangement and the cleats provided, see Fig. 4.3 for a typical fixture.

all dimensions in mm  
inches given in parentheses

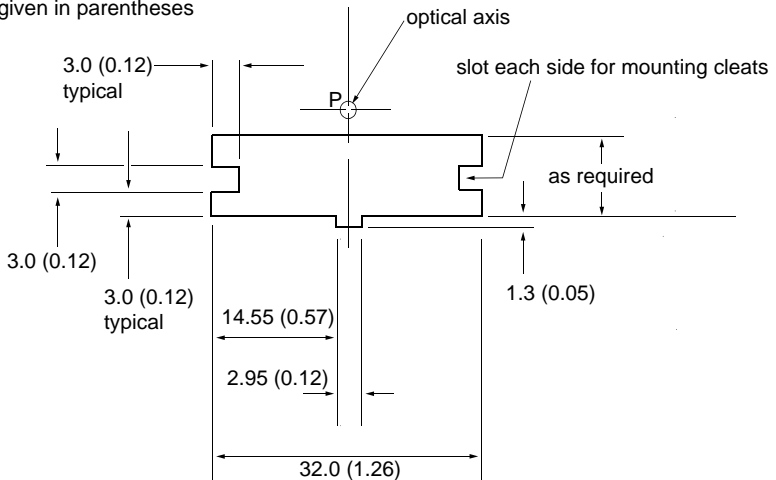


Fig. 4.3 Typical fixture, view along X-axis, length as required

## 4.6 Transportation



### Caution

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

4.7 Dimensions

4.7.1 Top Platform

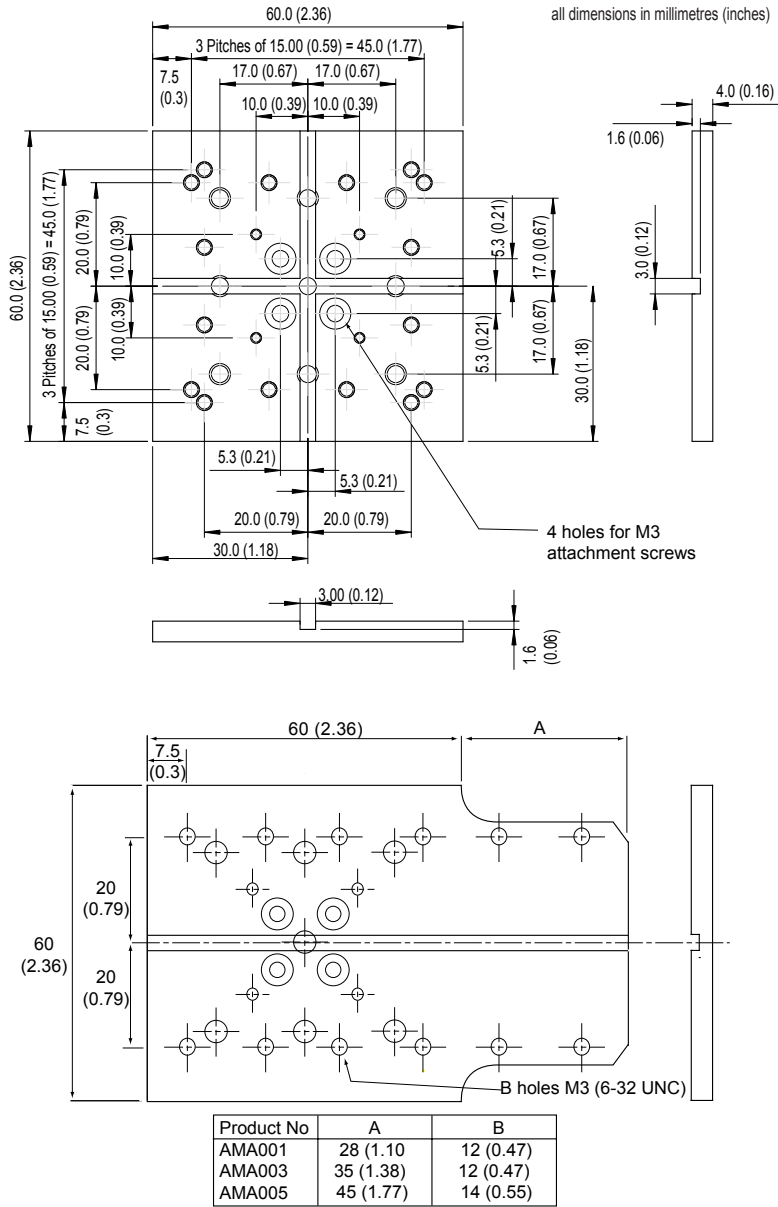


Fig. 4.4 Dimensions – top platform

## 4.8 Replacing the Top Platform

If desired, the top platform can be replaced by one of the AMA series extended platforms shown in the dimensions section, or by the RB13P1 adapter plate which offers an array of 1/4"-20 (M6) and 8-32 (M4) mounting holes. A replacement grooved top plate (MMP1) is also available.

In all cases, the top platform is secured to the stage using four M3 screws, irrespective of whether the stage is an imperial and metric model.



### **Caution**

When replacing or refitting the top plate, do not overtighten the retaining screws.

## Chapter 5 Maintenance and Troubleshooting

### 5.1 Maintenance of Motor Drives

After prolonged use, and particularly in applications where small movements are continually repeated, the grease on the drive shaft may build up in ridges. This may cause rough or noisy movement, vibration and excessive heating.

It is good practise to run the motor periodically from one end of travel to the other several times in order to redistribute the grease.

### 5.2 Troubleshooting



#### Caution

Under normal operation, the piezo mechanism uses contact with the micrometer drives in order to move the top platform. If for any reason the stage is operated with the micrometer drives removed, blanking plugs (DRV000 available as a custom from Thorlabs) must be fitted before the piezo actuators can function.

## Chapter 6 Specifications

### 6.1 Specifications

Parameter	Value
Load capacity	1 kg
Travel	Manual (coarse) and motor: 4 mm Manual (fine): 300µm Piezo: 20 micron
Resolution	Manual (coarse) 0.5 mm per revolution Manual (fine) 50 µm per revolution Piezo (without feedback) 20 nm Piezo (with feedback) 5 nm
<b>Note</b> The resolution of a manual drive corresponds to a 0.5 degree adjustment of the thimble; the actual resolution obtained depends on the skill of the user. The resolutions of the piezo actuators are those typically obtained using Thorlabs controllers.	
Piezo Capacitance	3.6 µF
Top Plate Parallelism Error	<100 µm
Arcuate displacement	See next page
Power supply	
Piezoactuated NanoMax	Nominal maximum input voltage: 75 V
Stepper Motor	Maximum input voltage: 24 V


**Caution**

The NanoMax should only be used in conjunction with the appropriate Thorlabs Piezoelectric Controllers.

**Arcuate Displacement**

The measured maximum cross talk to the Z axis, when a movement is demanded in X or Y is <88  $\mu\text{m}$ . The table below shows the theoretical amount of cross talk to the Z axis, for movement at various X positions (Y axis at zero).

Cross talk at Y axis positions (with X at zero) would be the same.

X axis position (mm):	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Arcuate Motion in Z axis ( $\mu\text{m}$ )	88.0	45.0	20.0	5.0	0.0	5.0	20.0	45.0	88.0

The measured maximum cross talk to the X and Y axes, when a movement is demanded in Z is <66  $\mu\text{m}$ . The table below shows the theoretical amount of cross talk to the X axis, for movement at various Z axis positions (Y axis at zero).

Cross talk to Y axis positions (with X axis at zero) would be the same..

Z axis position (mm):	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Arcuate Motion in X axis ( $\mu\text{m}$ )	57.1	32.1	14.3	3.6	0.0	3.6	14.3	32.1	57.1

## 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, pursuant 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 Certificate



**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: **Max381 and 383 Series**

Equipment: **3-Axis Flexure 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:

is exempt from the requirements of the Directive because its intended application is excluded pursuant to Annex III or Annex IV of the Directive. Exemption 7 C 1 applies.

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: 28 September 2018

Name: Keith Dhese  
Position: General Manager EDC - Max381 and 383 Series - 2018-09-28





## Chapter 8 Thorlabs Worldwide Contacts

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



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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 disassembled 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.



**UNLEASHED**



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