



# MAX300 Series NanoMax 3-Axis Flexure Stage

## User Guide



Original Instructions

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# Chapter 1 Safety





## 1.1 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.

	<b>Shock Warning</b>	
Given when there is a risk of injury from electrical shock.		
	<b>Warning</b>	
Given when there is a risk of injury to users.		
	<b>Caution</b>	
Given when there is a risk of damage to the product.		
<b>Note</b>		
Clarification of an instruction or additional information.		

## 1.2 General Warnings

	<b>Shock Warning</b>	
<p>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.</p> <p>Appropriate care should be taken when using this device.</p> <p>Persons using the device must understand the hazards associated with using high voltages and the steps necessary to avoid risk of electrical shock.</p>		
	<b>Warnings</b>	
<p>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.</p> <p>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.</p>		

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## Chapter 2 Introduction

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

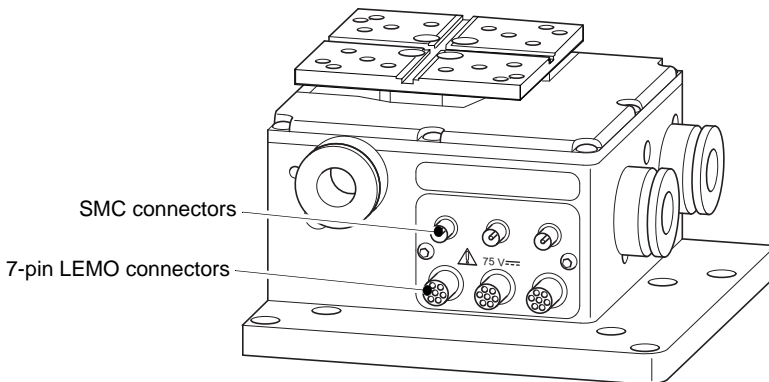
The NanoMax 3 axis flexure stage has been designed to integrate seamlessly into the Thorlabs Modular Electronic System and provide nanometric positioning on three orthogonal axes. It is suited to the alignment of optical fibres, waveguides, optoelectronic packages and any other high resolution alignment 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 DRV001 stepper motor drive, the DRV3 differential micrometer and the DRV004 thumbscrew. Also available are two external piezo actuators which increase the piezo travel to 40  $\mu\text{m}$  or 100  $\mu\text{m}$ .

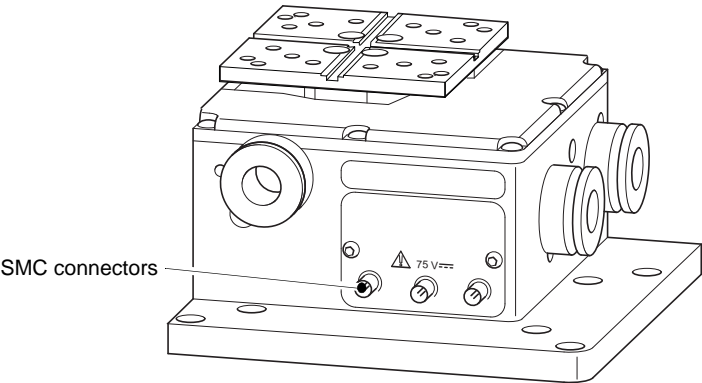
### 2.2 Component Identification

#### 2.2.1 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. 2.1 to Fig. 2.4.



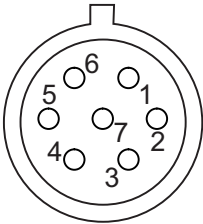
**Fig. 2.1 MAX301 NanoMax piezo-actuated stage with feedback on all axes**



**Fig. 2.2 MAX302 NanoMax piezo-actuated stage without feedback**

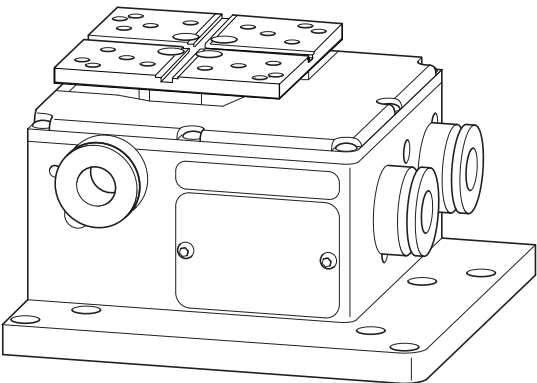
The piezo-actuated models deliver 20 microns of travel, each piezo channel has a coaxial SMC connector (see Fig. 2.1 and Fig. 2.2). In addition, the NanoMax 301 has a 7-pin LEMO connector for each feedback channel (see Fig. 2.1). A corresponding number of leads for connection to the Thorlabs piezoelectric 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. 2.3 Feedback Lemo connector pin functions**

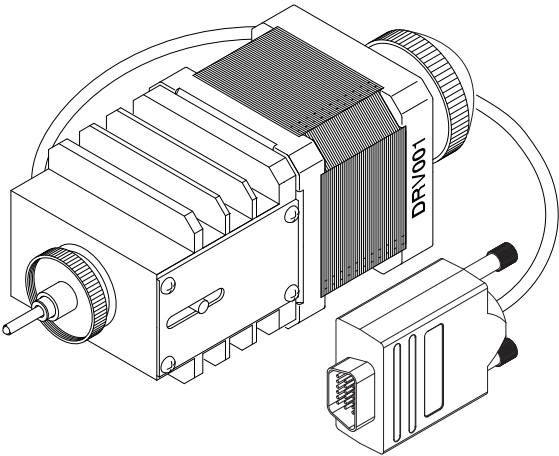


**Fig. 2.4 MAX303 NanoMax without piezo-actuation**

The NanoMax 303 has no electrical connections.

**2.2.2 Drives and Actuators**

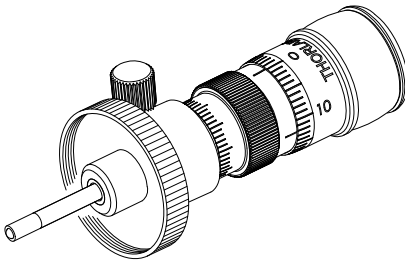
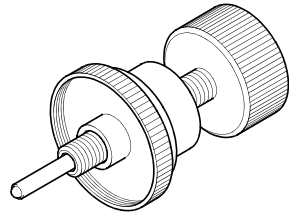
There are three types of drive available for the NanoMax, a motorized drive as shown in Fig. 2.5. and two manual drives as shown in Fig. 2.6. In addition, external piezo actuators are available to give an additional 20  $\mu\text{m}$  or 80 $\mu\text{m}$  piezo travel – see Fig. 2.7..



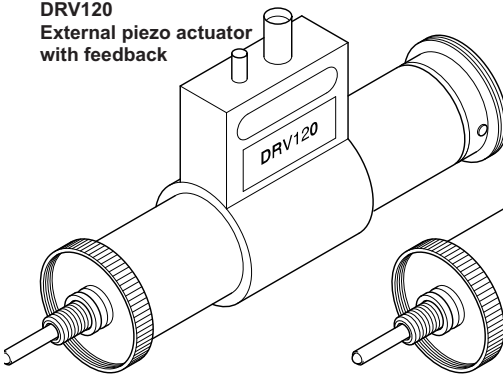
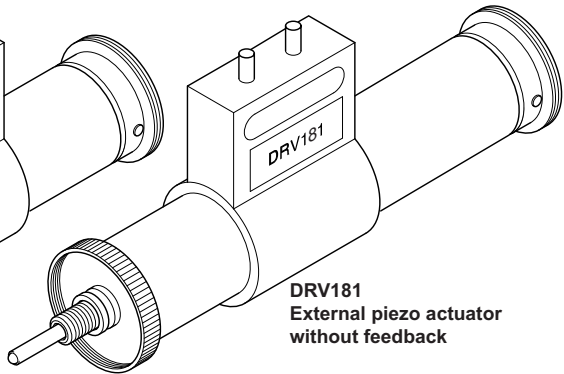
**Note**

The DRV001 stepper motor drive should be used in conjunction with the BSC benchtop driver or the MST602 control module.

**Fig. 2.5 DRV001 NanoStep motor drive**

**DRV3 differential micrometer drive****DRV004 thumbscrew drive****Fig. 2.6 Manual Drives**

These external piezo actuators 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. The DRV181 gives 80  $\mu\text{m}$  of travel.

**DRV120**  
External piezo actuator  
with feedback**DRV181**  
External piezo actuator  
without feedback**Fig. 2.7 External piezo actuators**

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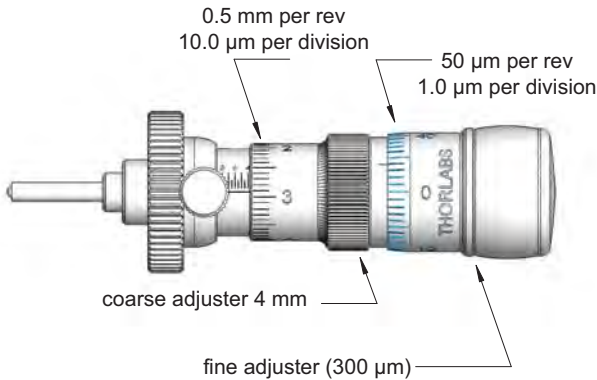
## Chapter 3 Operation

### 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.).

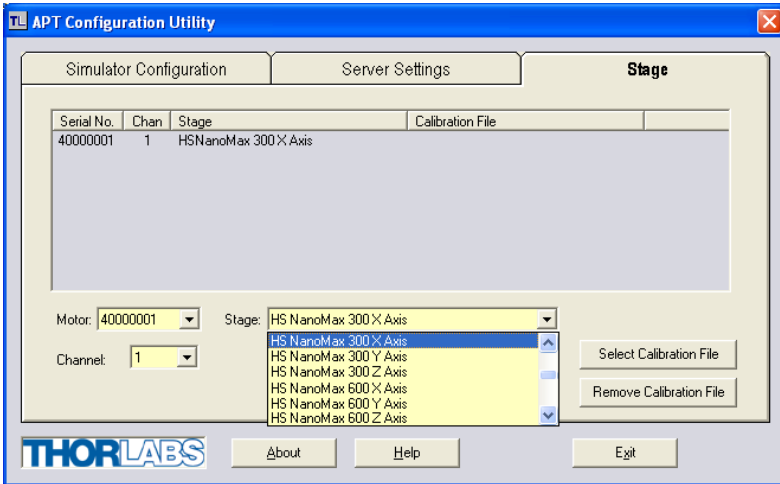
To assist in setting these parameters correctly, it is possible, using the APT Config utility, to associate a specific stage type and axis with the motor controller channel. Once this association has been made, the APT server applies automatically, suitable default parameter values on boot up of the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

To ensure correct operation, it is important to select the correct stage type for your controller. If using a BSC20x series controller, select the appropriate 'HS NanoMax' option. If using a legacy BSC0xx or BSC10x controller, choose an option without the 'HS' prefix.

- 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. 3.2 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).

### Note

**To ensure correct operation, it is important to select the correct stage and axis type. If using a BSC20x series controller, select the appropriate 'HS NanoMax' option. If using a legacy BSC0xx or BSC10x controller, choose an option without the 'HS' prefix.**

**Selecting an incompatible stage/axis type could result in reduced velocity and resolution.**

- 5) In the 'Stage' field, select your actuator type from the list displayed (e.g. HS NanoMax 300 X Axis).
- 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. See the handbook supplied with the stepper motor controller for further information.

### Notes

The NanoStep modular drives have no +ve limit switch. The drive reaches a mechanical stop at a position dependent on the axis to which it is attached. The design is such that occasional driving into the stop will not cause any damage.

If the axis is driven towards the –ve 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 creating a program to control the NanoMax, it is preferable to avoid running into the +ve limit.

## 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 pizo actuators can function.

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## 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*.

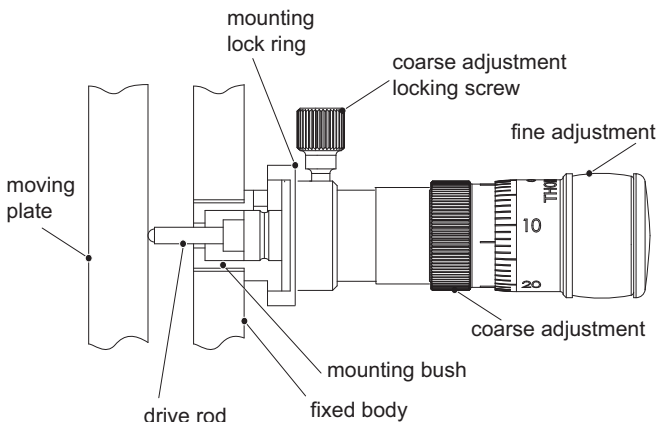
Then, referring to Fig. 4.1 on the next page...

- 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.

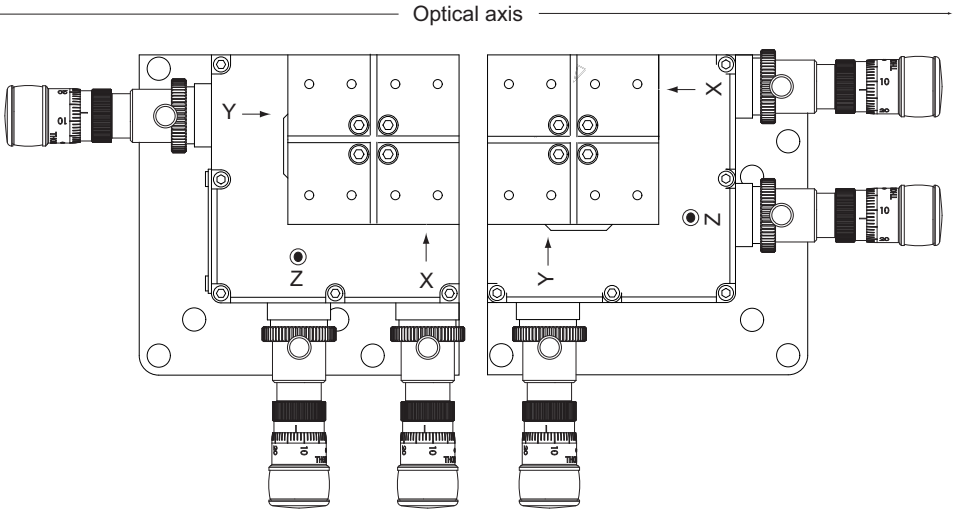




Fig. 4.2 Platform orientation

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 manufacture 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

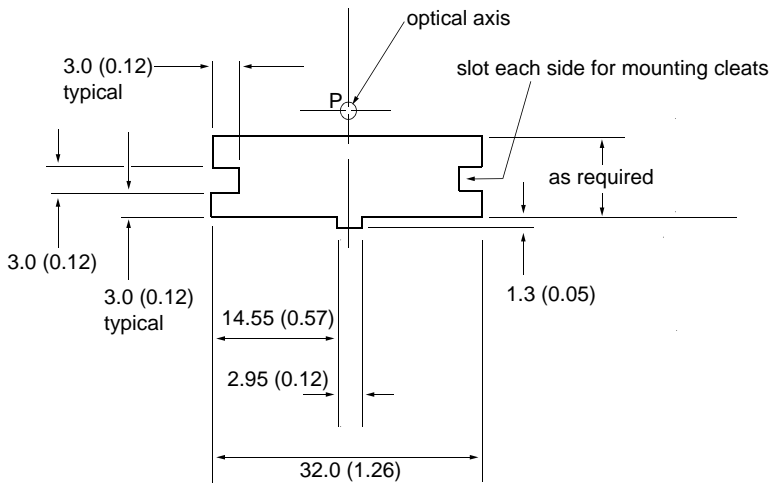




Fig. 4.3 Typical fixture, view along X-axis, length as required

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

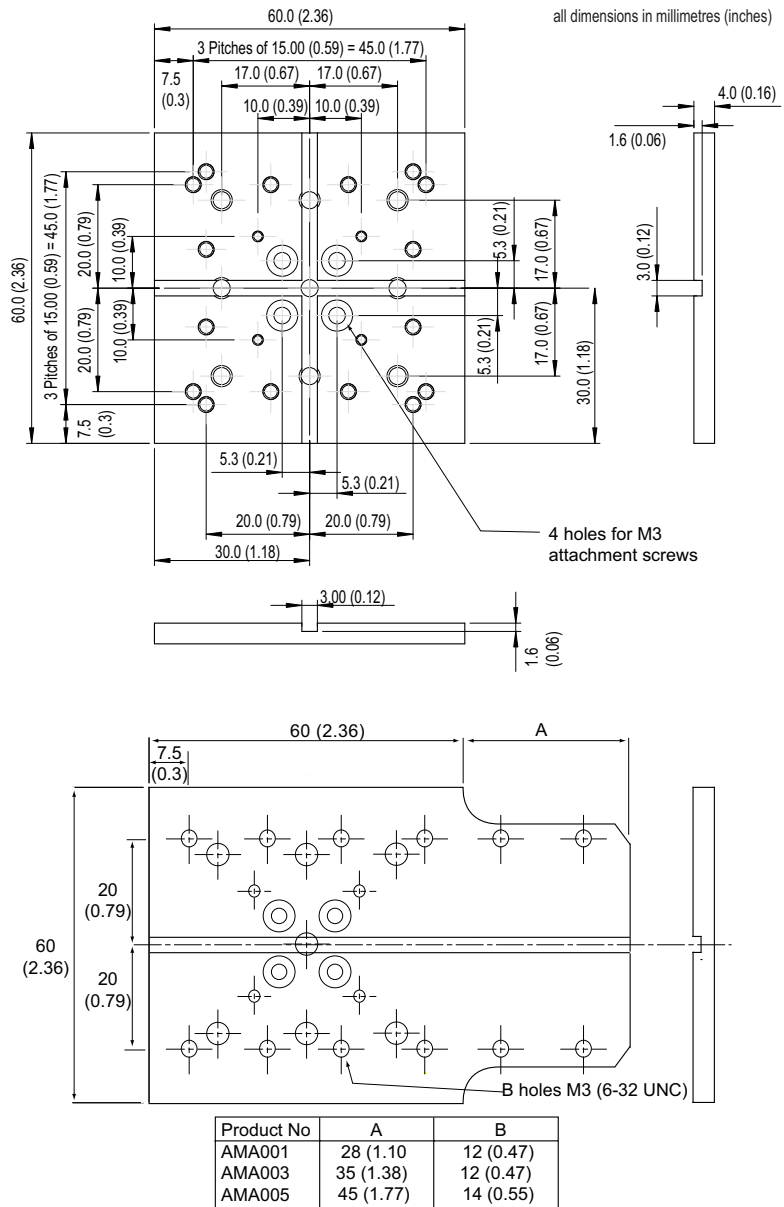


Fig. 4.4 Dimensions – top platform

4.7.2 External Piezo Actuators

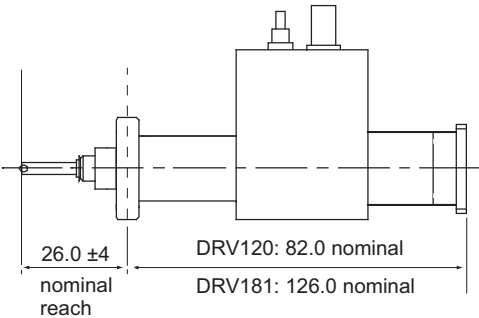


Fig. 4.5 External piezo actuators

4.7.3 Modular Drives

all dimensions in millimetres (inches)

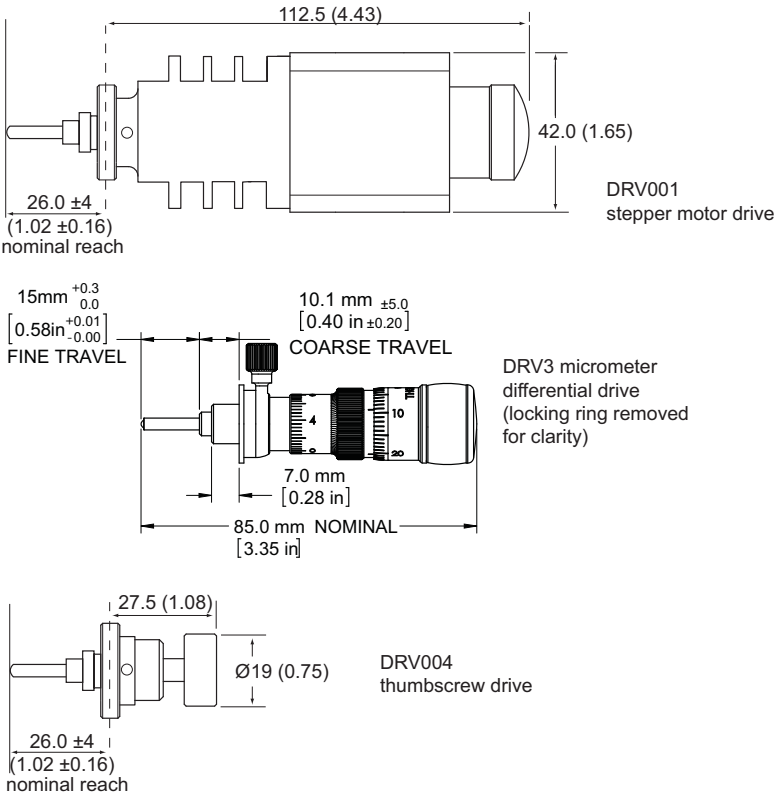


Fig. 4.6 Dimensions – modular drives



#### 4.7.4 NanoMax 3-Axis Stage

all dimensions in millimetres (inches)

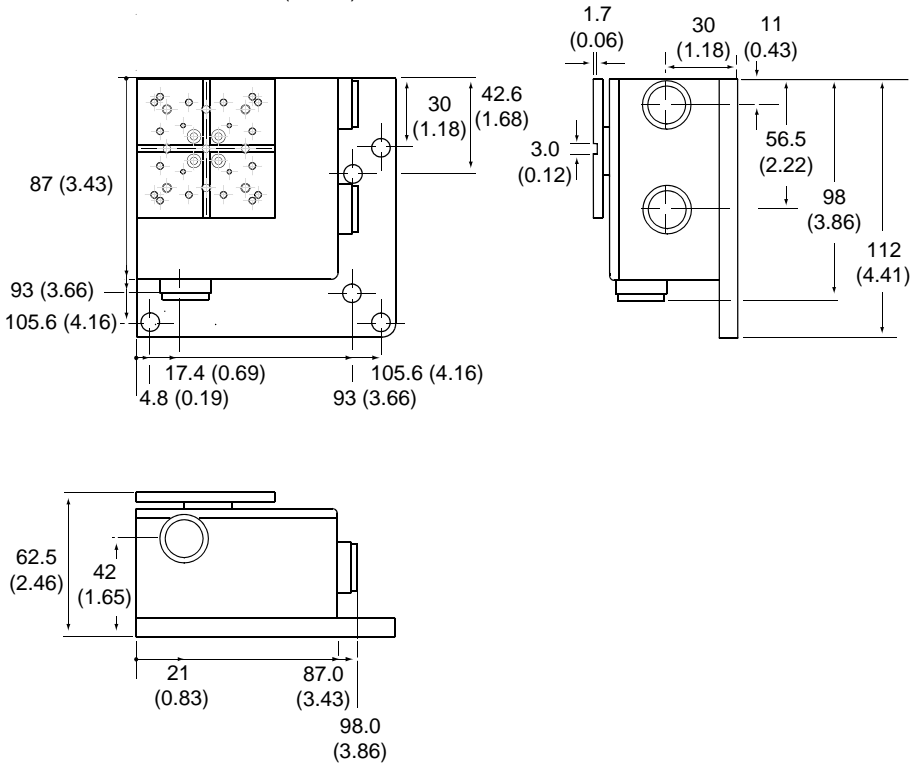


Fig. 4.7 Dimensions – NanoMax 3-axis stage

#### 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.**

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## 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) must be fitted before the pizo actuators can function.

# Chapter 6 Specifications and Parts List



## 6.1 Specifications

Parameter	Value
Load capacity:	1 kg
Travel	Manual (coarse) and motor4 mm Manual (fine) 300µm Piezo 20 micron
Resolution	Manual (coarse) 0.5 mm per revolution Manual (fine) 50 µm per revolution Motor 0.06 µm min incremental movement Piezo (without feedback) 20 nm Piezo (with feedback) 5 nm

Note

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 resolution of the motor drives is the smallest step that can be executed (i.e. 1 microstep). 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 Absolute maximum input voltage: 100 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 µm. 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 (µm)	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 µm. 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 (µm)	57.1	32.1	14.3	3.6	0.0	3.6	14.3	32.1	57.1

**6.2 Parts List**

Part Number	Description
MAX313D and MAX313D/M	NanoMax stage with differential micrometer drives
MAX312D and MAX312D/M	NanoMax stage with piezo actuator and differential micrometer drives
MAX311D and MAX311D/M	NanoMax stage with feedback piezo actuator and differential micrometer drives.
MAX343 and MAX343/M	NanoMax stage with stepper motor drives.
MAX341 and MAX341/M	NanoMax stage with feedback piezo actuator and stepper motor drives.
MAX303 and MAX303/M	NanoMax stage only
MAX302 and MAX302/M	NanoMax stage with piezo actuator
MAX301 and MAX301/M	NanoMax stage with feedback piezo actuator.

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## Chapter 7 Regulatory

### 7.1 Declarations Of Conformity

#### 7.1.1 For Customers in Europe

This equipment has been tested and found to comply with the EC Directives 89/336/EEC 'EMC Directive' and 73/23/EEC 'Low Voltage Directive' as amended by 93/68/EEC.

Compliance was demonstrated by conformance to the following specifications which have been listed in the Official Journal of the European Communities:

Safety	EN61010: 2001 Installation Category II, Pollution Degree II.
EMC	EN61326: 1997

#### 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 Waste Electrical and Electronic Equipment (WEEE) Directive

#### 7.2.1 Compliance

As required by the Waste Electrical and Electronic Equipment (WEEE) Directive of the European Community and the corresponding national laws, we offer all end users in the EC the possibility to return "end of life" units without incurring disposal charges.

This offer is valid for electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out "wheelie bin" logo (see Fig. 1)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated



**Fig. 7.1 Crossed out "wheelie bin" symbol**

As the WEEE directive applies to self contained operational electrical and electronic products, this "end of life" take back service does not refer to other products, such as

- pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- components
- mechanics and optics
- left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

### **7.2.2 Waste treatment on your own responsibility**

If you do not return an "end of life" unit to the company, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

### **7.2.3 Ecological background**

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

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## 7.3 CE Certificate



### E C Declaration of Conformity

We,

Thorlabs Ltd  
1 Saint Thomas Place,  
Cambridgeshire Business Park,  
Ely, Cambridgeshire  
CB7 4EX

declare that the motorized or piezo equipped travelling stages of the MAX3xx series comply with the following Harmonized European Standards:

BS EN 61326-1:1998  
BS EN 61000-3-2: 2000  
BS EN 61000-3-3: 1995  
EN 61010-1: 2001

And is in conformity with

93/68/EEC – CE Marking Directive (1996)  
89/336/EEC – EMC Directive (1996)  
73/23/EEC – Low Voltage Directive (1997)

Signed in **Ely**  
(place)

On the 5 day of January 2011  
(day) (month) (year)

Signature:

A handwritten signature in black ink, appearing to be "J. Mills", followed by a horizontal line extending to the right.

Name: **Jason Mills**

Position: **General Manager**

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## Chapter 8 Thorlabs Worldwide Contacts

### USA, Canada, and South America

Thorlabs, Inc.  
56 Sparta Ave  
Newton, NJ 07860  
USA  
Tel: 973-579-7227  
Fax: 973-300-3600  
www.thorlabs.com  
www.thorlabs.us (West Coast)  
email: feedback@thorlabs.com  
Support: techsupport@thorlabs.com

### Europe

Thorlabs GmbH  
Hans-Böckler-Str. 6  
85221 Dachau  
Germany  
Tel: +49-(0)8131-5956-0  
Fax: +49-(0)8131-5956-99  
www.thorlabs.de  
email: Europe@thorlabs.com

### UK and Ireland

Thorlabs Ltd.  
1 Saint Thomas Place, Ely  
Cambridgeshire CB7 4EX  
Great Britain  
Tel: +44 (0)1353-654440  
Fax: +44 (0)1353-654444  
www.thorlabs.de  
email: sales@uk.thorlabs.com  
Support: techsupport.uk@thorlabs.com

### France

Thorlabs SAS  
109, rue des Côtes  
78600 Maisons-Laffitte  
France  
Tel: +33 (0) 970 444 844  
Fax: +33 (0) 811 381 748  
www.thorlabs.de  
email: sales.fr@thorlabs.com

### Scandinavia

Thorlabs Sweden AB  
Box 141 94  
400 20 Göteborg  
Sweden  
Tel: +46-31-733-30-00  
Fax: +46-31-703-40-45  
www.thorlabs.de  
email: scandinavia@thorlabs.com

### Japan

Thorlabs Japan Inc.  
Higashi Ikebukuro  
Q Building 1st Floor 2-23-2  
Toshima-ku, Tokyo 170-0013  
Japan  
Tel: +81-3-5979-8889  
Fax: +81-3-5979-7285  
www.thorlabs.jp  
email: sales@thorlabs.jp

### China

Thorlabs China  
Oasis Middlering Centre  
3 Building 712 Room  
915 Zhen Bei Road  
Shanghai  
China  
Tel: +86 (0)21-32513486  
Fax: +86 (0)21-32513480  
www.thorlabs.com  
email: chinasales@thorlabs.com

### Brazil

Thorlabs Vendas de Fotônicos Ltda.  
Rua Riachuelo, 171  
São Carlos, SP 13560-110  
Brazil  
Tel: +55-16-3413 7062  
Fax: +55-16-3413 7064  
www.thorlabs.com  
Email: brasil@thorlabs.com



Thorlabs Inc.  
56 Sparta Ave  
Newton, NJ07860  
USA  
Tel: +1 973 579 7227  
Fax: +1 973 300 3600  
www.thorlabs.com

Thorlabs Ltd.  
Saint Thomas Place, Ely  
Cambridgeshire CB7 4EX,  
UK  
Tel: +44 (0) 1353 654440  
Fax: +44 (0) 1353 654444  
www.thorlabs.com