MAX600 Series
NanoMax 6-Axis Flexure Stage

User Guide

Contents

Chapter 1 Introduction

1.1 Description of the NanoMax 6-Axis Flexure Stage

The NanoMax 6-axis flexure stage has been designed to integrate seamlessly into the Thorlabs Electronic Control System and provide nanometric positioning in six axes, about a common rotation point. 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 standard types of drive are available, the DRV208 stepper motor drive, the DRV3 differential micrometer drive and the DRV004 thumbscrew drive. External piezo actuators are also available, which give 20 μm travel to models without internal piezos. For models fitted with internal piezo actuators, these external drives increase the piezo travel to 50 μm.

Description	Product Number
Six-axis flexure stage preconfigured with Differential Drives	MAX601D
Six-axis flexure stage with internal piezos (no feedback) preconfigured with Differential Drives	MAX602D
Six-axis flexure stage with internal feedback piezos, preconfigured with Differential Drives	MAX603D
Six-axis flexure stage preconfigured with Stepper Motor Drives	MAX681
Six-axis flexure stage with internal piezos (no feedback) preconfigured with Stepper Motor Drives	MAX682
Six-axis flexure stage with internal feedback piezos preconfigured with Stepper Motor Drives	MAX683
The following models are supplied unconfigured, allowing the customer to select the most suitable actuator for each axis. Left handed versions (/L) are also available	
Six-axis flexure stage without piezo actuators	MAX607 (/L)
Six-axis flexure stage without position feedback piezo	MAX608 (/L)
Six-axis flexure stage with active position feedback piezo on all axes	MAX609 (/L)

1.2 Component Identification

1.2.1 NanoMax-TS Stage

The NanoMax 6-axis flexure stage (see Figs 3.1 and 3.2) is available in six versions, each with left or right handed configuration as detailed in Table 3.1.

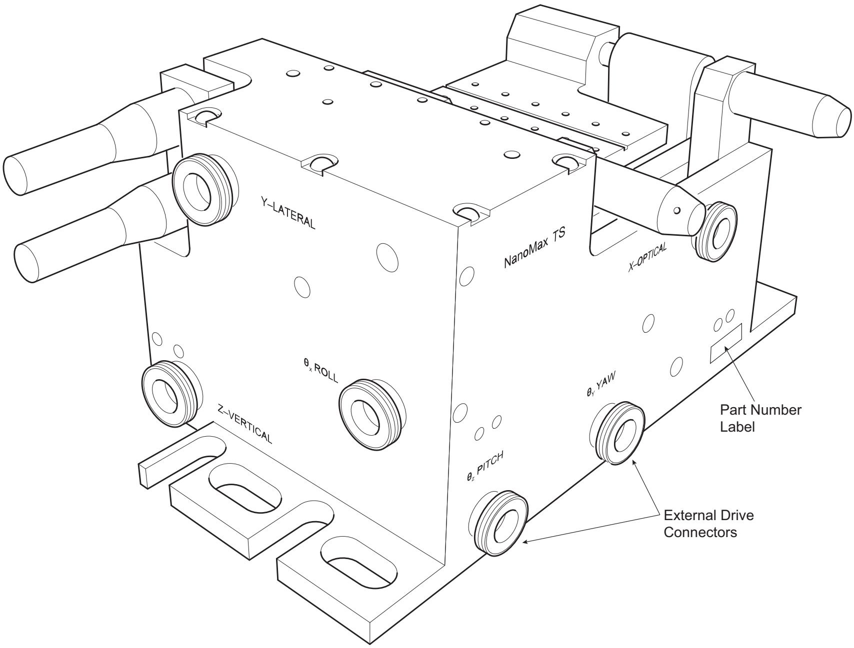


Fig. 1.1 MAX607 right handed NanoMax six-axis stage

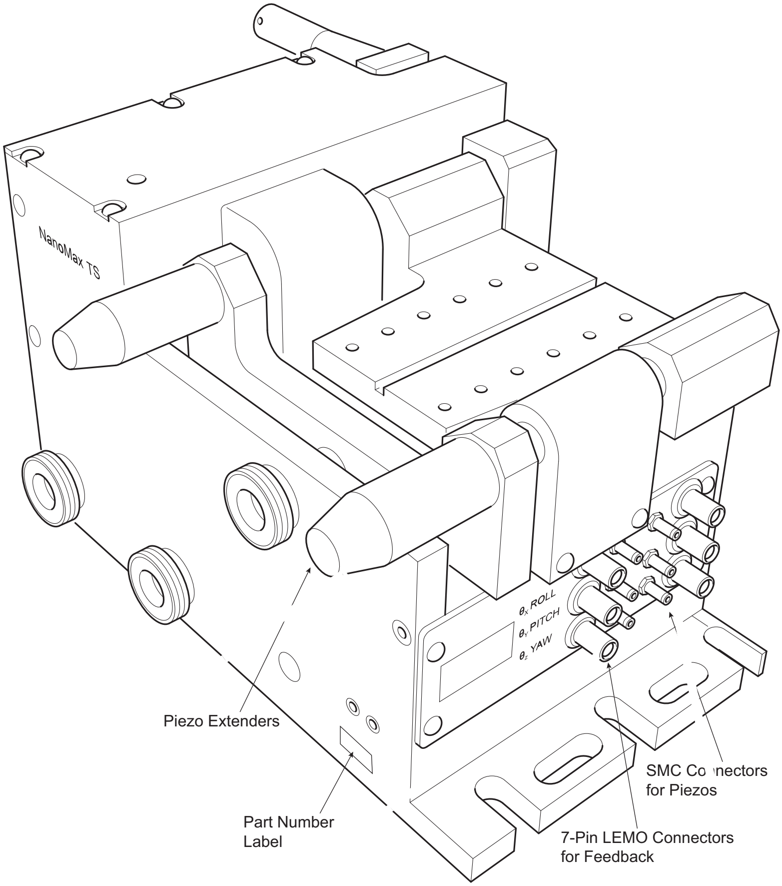
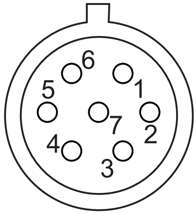


Fig. 1.2 MAX609 right handed NanoMax, piezo-actuated stage with feedback

The piezo-actuated models deliver 30 microns of travel, with a coaxial SMC connector for each piezo channel.

Position feedback models have a 7-pin LEMO connector for each feedback channel (see Fig. 1.2). The pin functions 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

1.2.2 Drives and Actuators

There are three types of standard drive available for the NanoMax, a motorized drive as shown in Fig. 1.4. and two manual drives as shown in Fig. 1.5. In addition, external piezo actuators are available to give an additional 20 µm piezo travel – see Fig. 1.6.

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Note

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

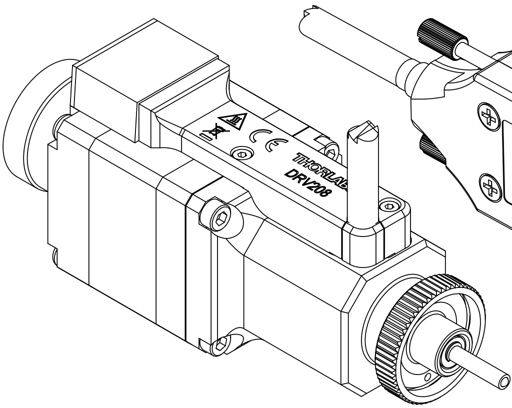
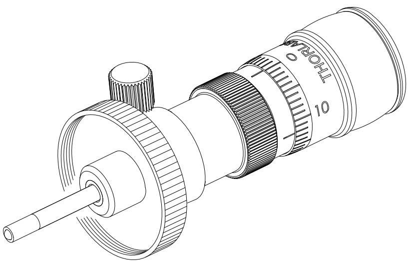
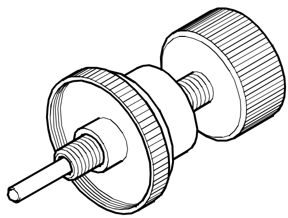


Fig. 1.4 Motorised drive



DRV3 differential micrometer drive



DRV004 thumbscrew drive

Fig. 1.5 Manual Drives

These external piezo actuators can be fitted in-line with the standard drives described on the previous page and provide an additional 20 µm or 1.2 arcmins of piezo travel.

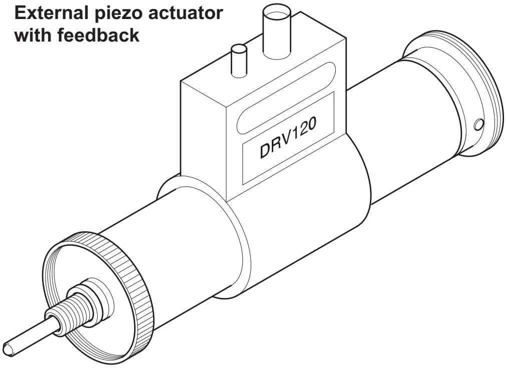


Fig. 1.6 DRV120 External piezo actuator

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 absorbent tissue. Do not allow spilled fluid to enter the internal mechanism.

Chapter 3 Operation

3.1 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:

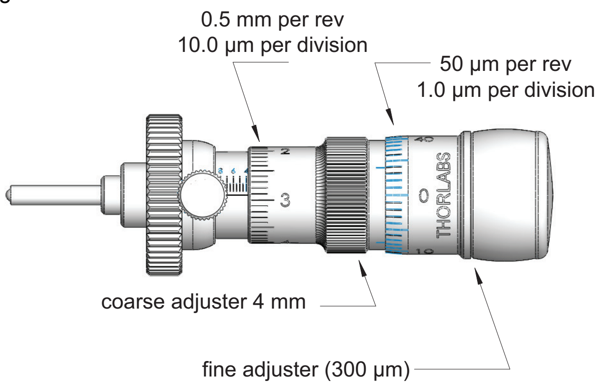


Fig. 3.1 Reading micrometer drives

3.1.3 Converting Micrometer Movement to Axis Movement

The Z axis moves by the micrometer reading in mm. However, on the X and Y axes there is a gearing ratio of 1:1.5 in the NanoMax. Therefore the platform moves 1.5 mm for every 1 mm of movement at the micrometer. On the angular axes, the micrometer reading in mm translates to degrees of movement of the top platform.

Note

The 1:1.5 gear ratio in the X and Y axes is applicable only when using micrometer actuators. When using stepper motor or piezo actuators, the software automatically adjusts to a 1:1 ratio.

Axis	Amount of movement resulting from a 1mm movement of the micrometer
X (Optical)	1.5mm
Y (Lateral)	1.5mm
Z (Vertical)	1mm
ØX (Roll)	1 degree
ØY (Pitch)	1 degree
ØZ (Yaw)	1 degree

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.

Caution

For best performance, all axes should be controlled using the same software, either Kinesis or APT.

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.

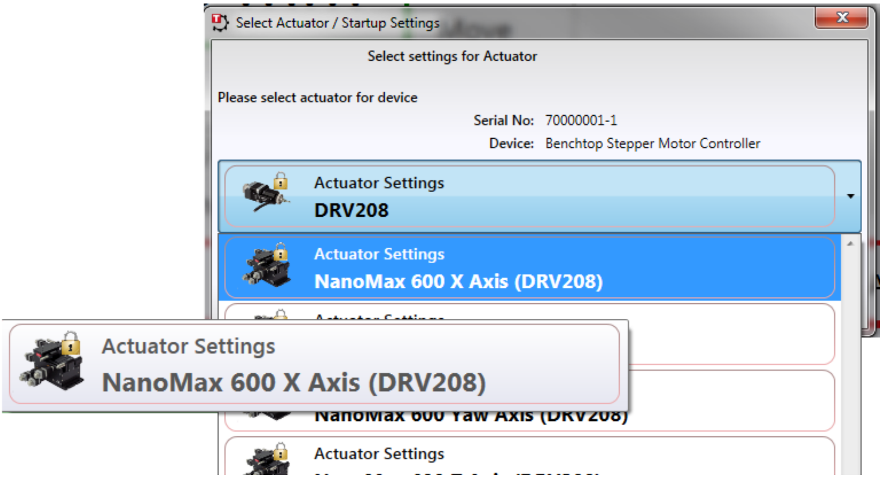


Fig. 3.2 Stage Configuration Window

4) Select your stage type (e.g. NanoMax 600 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.

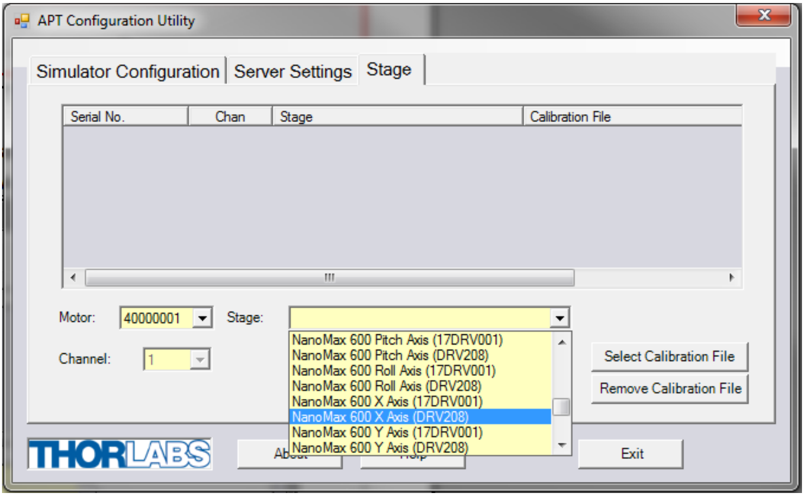


Fig. 3.3 APT Configuration Utility - Stage Tab

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 600 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.

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.

Models fitted with internal piezo actuators to give nanometric positioning of the top platform over a range of 30 microns (50µm if external piezo actuators are used). This piezo travel is in series with the travel of the associated actuator. 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.

Please note that 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. To order blanking plugs, please contact Tech Support.

3.4 Common Rotation Point P

It is usual to attach a fibre holder so that the tip of the fibre is held at the common rotation point P, with the NanoMax in mid position on all axes (see Fig. 4.5). If the moving platform is moved from its mid position, the point P also moves relative to the base, retaining its position relative to the moving platform.

A pointed probe, indicating the point P, is fitted to the stage on shipping. To remove this probe, loosen the M3 socket set screw in line with the base of the probe.

Warning

The probe that identifies the common rotation point P is very sharp. During operation, take care when mounting or removing devices and accessories in this area.

If the probe is not being used it should be removed.

3.5 The Mid Position

When all the axes are at mid position, point P will be in its nominal position and the platform will be square and level with the base.

It is recommended to use this position as the nominal position for your positioning task. The arcuate displacement of the flexure system is minimized at the mid position.

Due to build tolerances and mechanical losses, the midpoint of travel will be a different micrometer reading from stage to stage. In general, the midpoint will be 2 mm from the point at which the axis first starts to move.

In the case of motor drives, the mid position is half the full range of travel, (i.e. 2mm for X, Y and Z axes and 3 degrees for Øx, Øy and Øz axes.

Chapter 4 Installation

4.1 Unpacking

Note

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

To minimize the risk of transit damage, the NanoMax is shipped with its drive units detached.

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.

1) Remove the drives and leads from the shipping container.
2) Lift out the NanoMax by its handle.
3) Place the NanoMax on the surface where it is to be used.
4) Undo the three black plastic thumbscrew retainers – see Fig. 4.1.
5) Retain the red transit cover and inserts for future use when shipping the NanoMax.

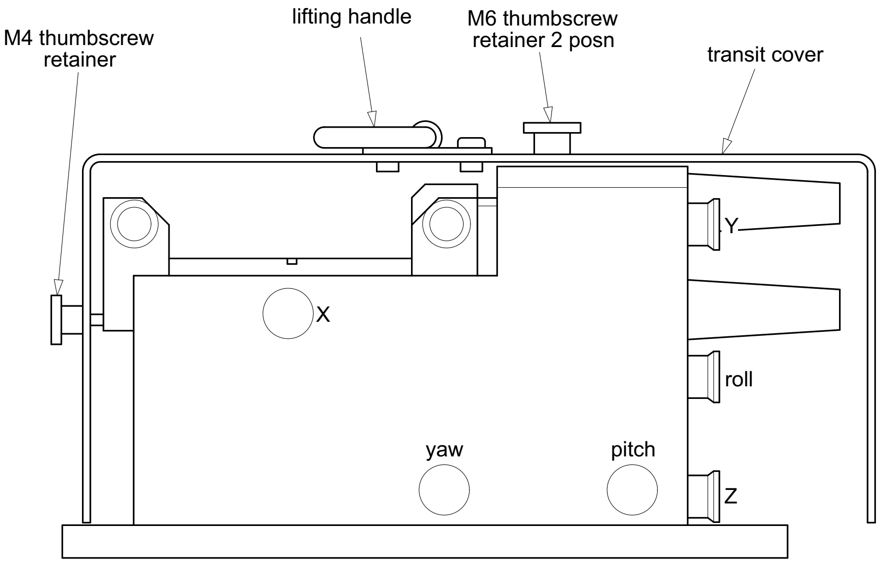


Fig. 4.1 Left-handed NanoMax with transit cover attached

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. Bolting the unit down minimizes the risk of damage from dropping.

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 ± 2 mm about the nominal position.

4.3 Fitting and Removal of Drives

4.3.1 Preparation

The NanoMax is shipped with white nylon transit inserts fitted to the mounting bushes (see Fig. 4.2) which must be removed before a drive can be fitted.

Warning

When the transit inserts are removed, the internal mechanism will revert back to its pre-loaded retracted position. Keep fingers away from moving parts when removing these inserts.

1) Unscrew and remove the transit inserts from all six axes
2) Retain the inserts for future use when shipping the unit.

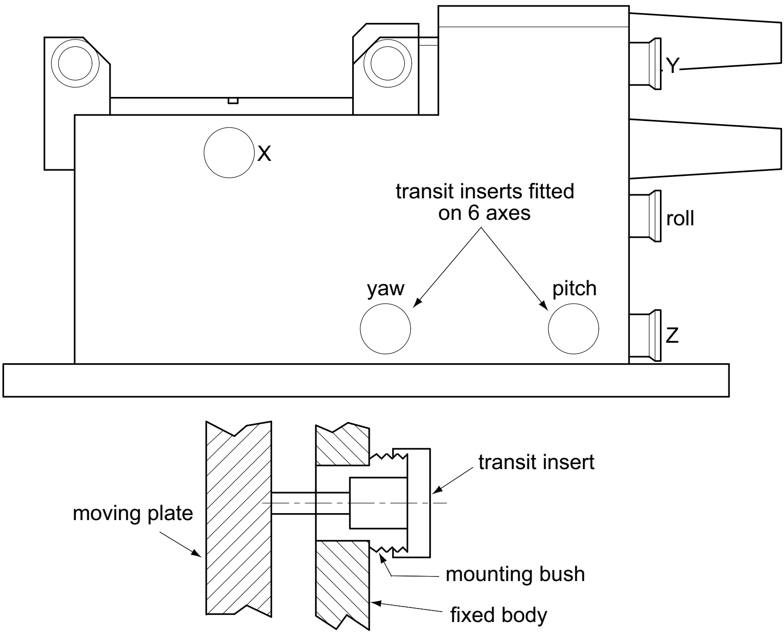


Fig. 4.2 Removal of transit inserts

4.3.2 Fitting a Drive

The procedure for fitting a drive to the NanoMax is as follows:

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

Then, referring to Fig. 4.3.

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

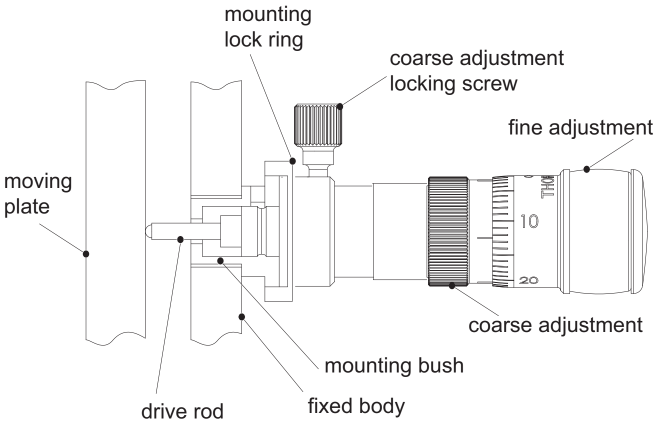


Fig. 4.3 Micrometer drive inserted into mounting bush

4) To remove a drive, reverse the above procedure.

Warning

When drives are removed, the internal mechanism will revert back to its pre-loaded retracted position. Keep fingers away from moving parts when removing drives.

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

4.4 Mounting Equipment to the Moving Platform

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. 4.4 for a typical fixture.

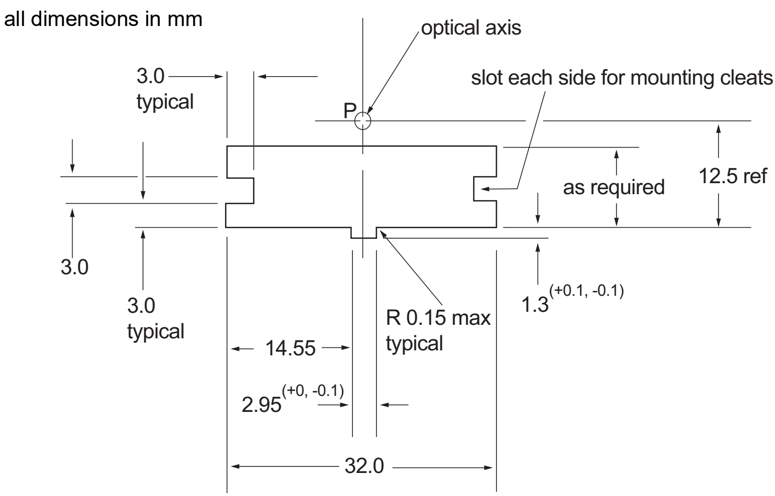


Fig. 4.4 Typical fixture, view along X-axis, length as required

4.5 Transportation

Caution

The drives should be removed before transporting the NanoMax.

When packing the unit for shipping, ensure that the transit cover is refitted. 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.

4.6 Dimensions

4.6.1 Top Platform

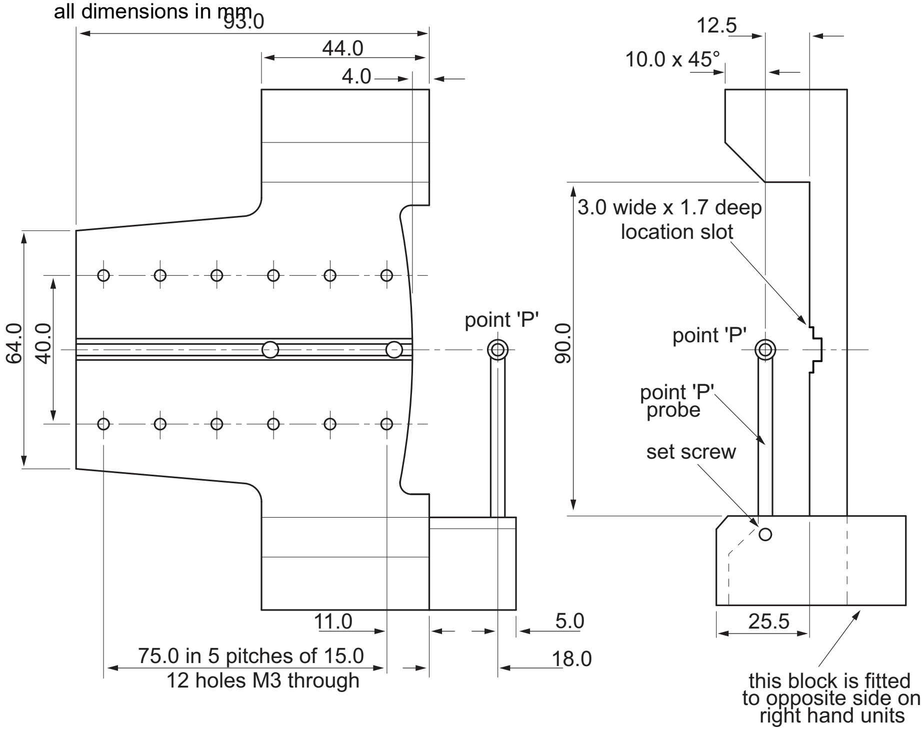


Fig. 4.5 Dimensions – top platform

4.6.2 External Piezo Actuators

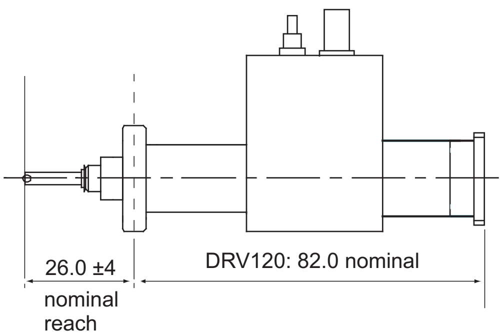


Fig. 4.6 External piezo actuators

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 part from Thorlabs) must be fitted before the Piezo actuators can function.

Chapter 6 Specifications

Parameter	Value
Weight (without drives)	5.0 kg
Load capacity	1 kg
Travel	Manual (coarse) and motor 4 mm Manual (fine) 300µm Piezo 30 µm
Resolution	See Table Below
Max Arcuate Displacement	80 µm
Power supply	
Piezo Drive voltage	Nominal maximum input voltage: 75 V Absolute maximum input voltage: 100V
Piezo Capacitance	Qty. 2 piezo in X & Y axes: 3600nF Total Qty. 3 piezo in Z, roll, pitch, and yaw: 5400nF Total
Stepper Motor	Maximum input voltage: 15V

Product	Theoretical Resolution with External Drive						
	External Drive	**X**	**Y**	**Z**	**Roll**	**Pitch**	**Yaw**
MAX601D MAX602D MAX603D	Differential Micrometer Drive DRV3	1.5 µm	1.5 µm	1.0 µm	17.0 µRad	17.0 µRad	17.0 µRad
MAX681 MAX682 MAX683	Stepper Motor Drive DRV208*	1.8 nm	1.8 nm	1.2 nm	0.021 µRad	0.021 µRad	0.021 µRad
MAX607 MAX608 MAX609	None Customizable	Depends on external drive chosen.					

*With BSC201 controller

Product	Theoretical Resolution with Internal Drive						
	Internal Drive	**X**	**Y**	**Z**	**Roll**	**Pitch**	**Yaw**
MAX601D MAX602D MAX603D	None Open Loop Piezo* Closed Loop Piezo*	N/A 1.0 nm 1.0 nm	N/A 1.0 nm 1.0 nm	N/A 1.0 nm 1.0 nm	N/A 0.018 µRad 0.018 µRad	N/A 0.018 µRad 0.018 µRad	N/A 0.018 µRad 0.018 µRad
MAX681 MAX682 MAX683	None Open Loop Piezo* Closed Loop Piezo*	N/A 1.0 nm 1.0 nm	N/A 1.0 nm 1.0 nm	N/A 1.0 nm 1.0 nm	N/A 0.018 µRad 0.018 µRad	N/A 0.018 µRad 0.018 µRad	N/A 0.018 µRad 0.018 µRad
MAX607 MAX608 MAX609	None Open Loop Piezo* Closed Loop Piezo*	N/A 1.0 nm 1.0 nm	N/A 1.0 nm 1.0 nm	N/A 1.0 nm 1.0 nm	N/A 0.018 µRad 0.018 µRad	N/A 0.018 µRad 0.018 µRad	N/A 0.018 µRad 0.018 µRad

*With BPC30X series controllers typically and based on 16-bit DAC

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: ***Max6xx Series***

Equipment: ***6-Axis Stage***

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.
Exemption 7 C 1 applies to Equipment containing Piezos.

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:* 30 November 2018

Name: Keith Dhese

Position: General Manager

EDC - Max6xx Series -2018-11-30

Chapter 8 Thorlabs Worldwide Contacts

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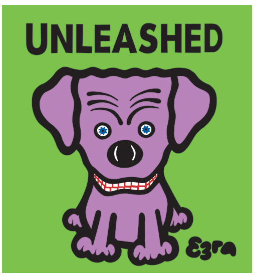
Email: chinasales@thorlabs.com

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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