THORLABS

# NRT Series
# Motorized Translation Stage

## User Guide

Original Instructions

# Contents

# Chapter 1 For Your 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.

**Shock Warning**

**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.**

## 1.2 General Warnings

**Warnings**

**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.**

**When running custom move sequences, or under fault conditions, the stage may move unexpectedly. Operators should take care when working inside the moving envelope of the stage.**

# Chapter 2 Overview

## 2.1 Introduction

The NRT series stages are performance positioning stages which are ideally suited for measurement and inspection applications that do not require very high precision or high load capacity. The main platform is supported by 4 recirculating ball carrier bearings mounted to precisely aligned linear guide rails. A backlash free precision lead screw produces smooth translation, directly driven with a hybrid 2-phase stepper motor capable of 409,600 micro steps per revolution, and positioning resolutions of less than 100nmwhen driven by the BSC series of benchtop controllers. The highly repeatable, Hall effect (magnetic) home detection limit switch also provides overdriving protection in both forward and reverse directions.

The high quality stepper motor offers excellent dynamic and static torque performance and the design provides the detailed features required of any true nanopositioning product.

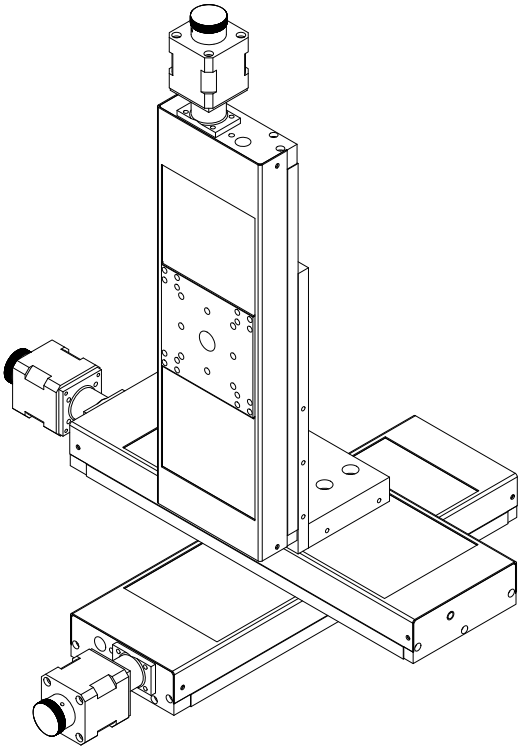


**Fig. 2.1 Typical XYZ Configuration**

# Chapter 3 Installation and Operation

**Note**

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

## 3.1 Mounting to a Work Surface

### 3.1.1 General

When mounting the NRT 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 for each model is as follows:

NRT100 - 100mm, NRT150 - 150mm.

## 3.2 Environmental Conditions

**Warning**

**Operation outside the following environmental limits may adversely affect operator safety.**

| | |
|---|---|
| Location | Indoor use only |
| Maximum altitude | 2000 m |
| Temperature range | 5°C to 40°C |
| Maximum Humidity | Less than 80% RH (non-condensing) at 31°C |

To ensure reliable operation the unit should not be exposed to corrosive agents or excessive moisture, heat or dust.

If the unit has been stored at a low temperature or in an environment of high humidity, it must be allowed to reach ambient conditions before being powered up.

The unit must not be used in an explosive environment.

### 3.2.1 Mounting a Single Stage to a Work Surface

The NRT stage is mounted to the working surface by M6 screws through the base. To access these mounting holes, turn the motor knob to move the carriage until the holes are visible through the center hole - see Fig. 3.1. The stage can also be mounted in other orientations - see Section 3.2.2. and 3.2.4

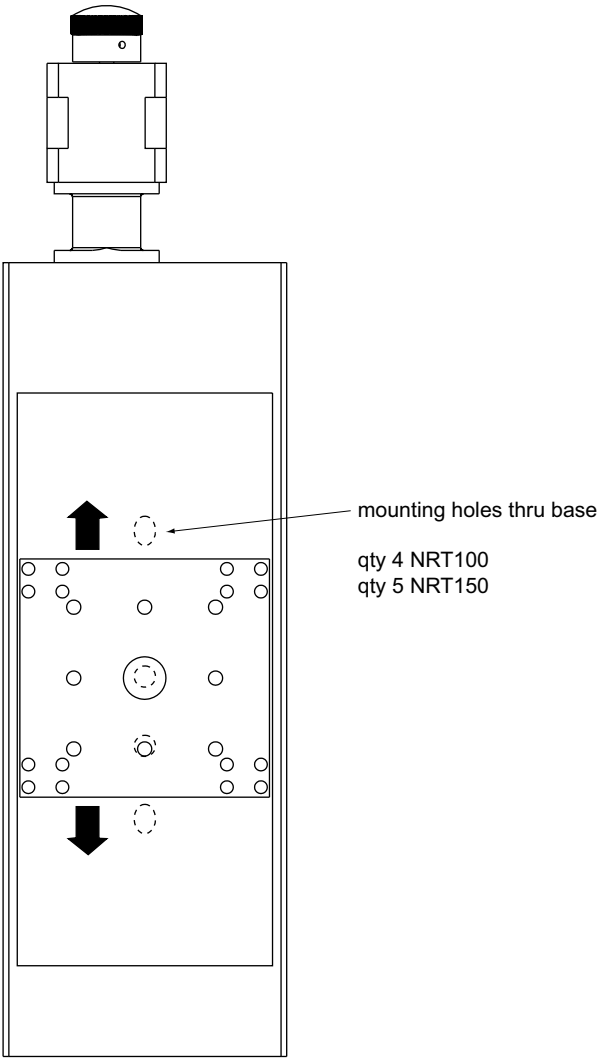



**Fig. 3.1 Mounting Holes**

### 3.2.2 Mounting stages in X-Y configurations

Tools required:

5mm hexagon key,

Qty 2, M6 x 12 (1/4-20 UNC x 1/2") cap head bolts,

Engineers square and a flat plate.

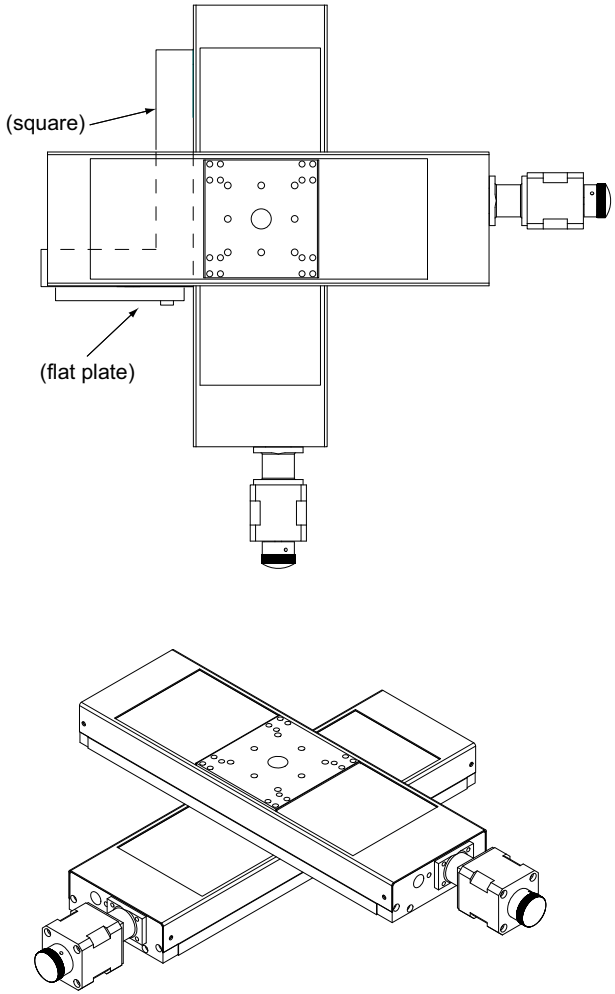



**Fig. 3.2 X-Y configuration**

1) Fix the X axis stage to the worksurface, as detailed in Section 3.2.1.
2) Turn the motor knob of the Y axis stage to move the top platform sufficiently to gain access to the fixing holes in the base plate.
3) Position the stages as shown in Fig. 3.2.
4) Fit and tighten the securing bolts then loosen 1/4 to 1/2 turn.

**Caution**

**Ensure that the screws do not foul the carriage as it moves backwards and forwards.**

5) If all fixing holes cannot be accessed, move the top platform as necessary to gain access, then repeat items 2) to 5).
6) Position the engineers square and flat plate as shown in Fig. 3.2.
7) Align the stages squarely then tighten the securing bolts.
8) Recheck that the stages are square and readjust as necessary.

### 3.2.3 Mounting stages in X-Y-Z configurations

1) Fix the X axis stage to the worksurface as detailed in Section 3.2.1.
2) Assemble two stages in an XY configuration as detailed in Section 3.2.2.
3) Fit the Z-bracket assembly (NRT150P1) to the Y axis stage and attach the Z axis stage as shown in Fig. 3.3.

If accurately square z-axis travel is required, use an engineering square to align the orthgonality of the z-axis travel by noting the size of the gap between the moving plate and the square at either end of vertical travel. It there is a noticable difference in the size of this gap then adjustments should be made through loosening/tightening of the mounting bracket to the stage:

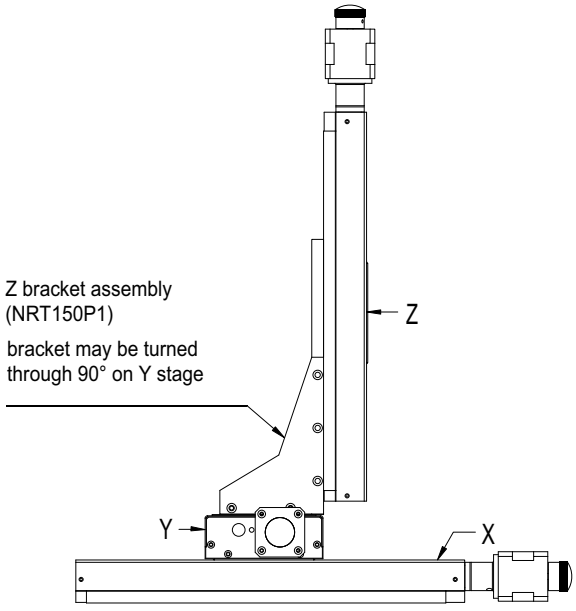



**Fig. 3.3 X-Y-Z configuration**

## 3.3 Operation

The NRT stage should be driven by the Thorlabs stepper motor BSC series controllers - see www.thorlabs.com for further details. The flying lead of the stage is terminated in a D-type connector - see Chapter 4 for pin out details, and should be connected to the controller via an extension cable which is available separately, PAA612 - 1 m (3.3') or PAA613 - 3 m (9.8').

**Caution**

**Do not attempt to control this stage using the KST101 or TST101 K-Cube or T-Cube controllers. There is no APT software configuration for use with these devices.**

**The stepper 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.**

**Because it can be software controlled it should be noted that this device could begin to move unexpectedly for a person within its envelope of operation, who had not programmed the move. However, max speed and load are such that risks are minimal.**

### 3.3.1 System Setup

1) Install the electronic hardware and connect the controller to the relevent axes of the associated stage(s) (see the handbooks supplied with the APT Controllers).
2) For each Stepper Motor Controller in your system, fit the interlock plug (supplied) to the MOTOR CONTROL connector on the rear panel.
3) Shut down all applications using the APT server (e.g. APT User or your own custom application).
4) Run the APT Config utility - Start/All Programs/Thorlabs/APT Config/APT Config.
5) From the 'APT Configuration Utility' window, click the 'Stage' tab.

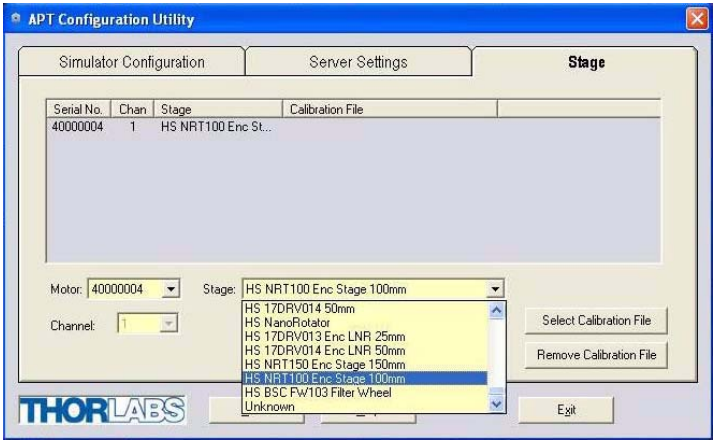



**Fig. 3.4 APT Configuration Utility - Stage Tab**

6) 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 type for your controller. If using a BSC20x series controller, select the appropriate ‘HS NRT 1x0 Enc’ option. If using a legacy BSC0xx or BSC10x controller, choose an option without the ‘HS’ prefix.**

**Selecting an incompatible stage type could result in reduced velocity and resolution or, when using a joystick, the joystick may be inoperable.**

7) In the ‘Stage’ field, select the stage (e.g. ‘HS NRT100 Enc’) from the list displayed.
8) Click the 'Add Stage Association' button.
9) 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.

## 3.4 Calibration of Motor Drives

Calibration enables the server to correct for any mechanical errors inherent in the system. Mechanical components, such as the leadscrew and linkages, can be machined only within a certain tolerance, e.g. the leadscrew may be nominally 1mm but actually 1.0005mm, giving a 0.5 micron error. In practice, these errors accumulate from a number of sources, however they are repeatable and therefore, can be compensated.

During calibration, the total positional error is measured at a large number of points and these errors are stored as a look up table (LUT). The LUT is saved as a calibration file, one file for each axis on a particular stage. These files are then linked to the appropriate axis as part of the Stage association process performed using the APT Config utility. Whenever the stage is moved, the LUT is consulted to ascertain the precise movement required to achieve the demanded position.

The use of a calibration file is optional. Without it, the repeatability and resolution of the stage are unaffected, but no compensations are made to enhance the accuracy

Details on assigning a calibration file are contained in the *APTConfig On Line Helpfile.*

## 3.5 Maintenance

The unit contains no user servicable parts and must be returne to the manufacturer for service and/or repair.

## 3.6 Transportation

**Caution**

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

## 3.7 Dimensions

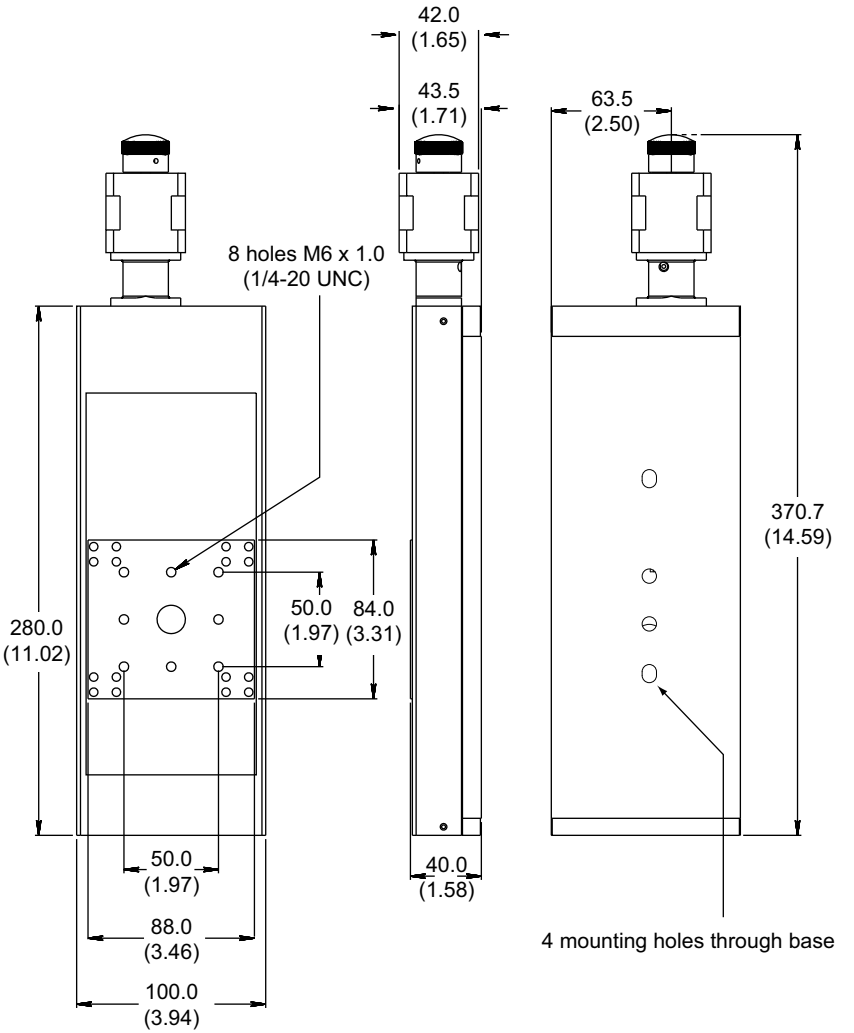



**Fig. 3.5 Dimensions - NRT100**

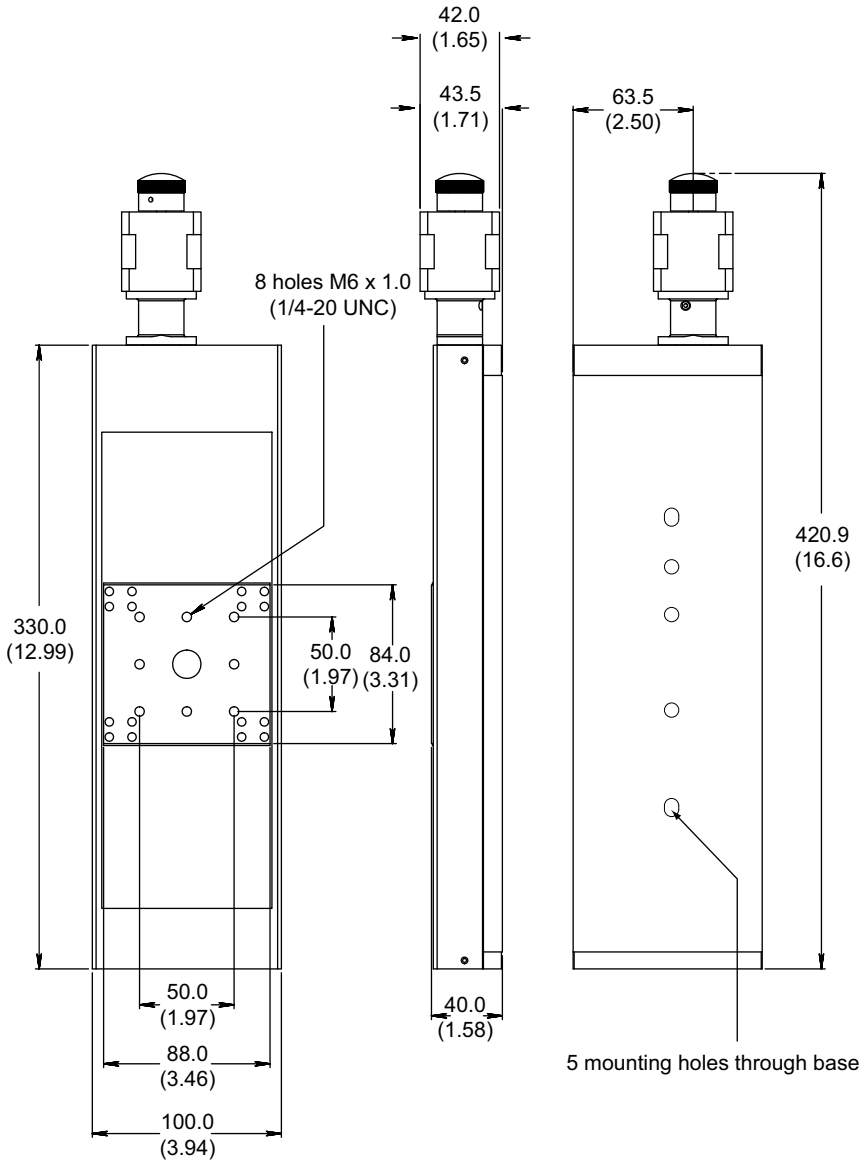



**Fig. 3.6 Dimensions - NRT150**

# Chapter 4 Specification

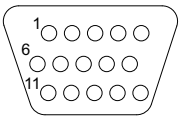
## 4.1 Stage Specification

| | | |
|---|---|---|
| Weight: | NRT100 | 2.2Kg (4.8 lb) |
| | NRT150 | 2.5Kg (5.5 lb) |
| Load capacity: | 20 kg Horizontal | |
| | 5 Kg Vertical | |
| Travel: | NRT100 | 100mm |
| | NRT150 | 150mm |
| Maximum velocity: | 30mm/s (using APT BSC20x Controller) | |
| Maximum acceleration: | 30mm/s/s (using APT BSC20x Controller) | |
| Min Achievable Incremental Movement: | 0.1 µm | |
| Bi-Directional Repeatability: | 1µm | |
| Absolute On-axis Accuracy: | NRT100 | 15.29 µm |
| | NRT150 | 19.29 µm |
| Calibrated On-axis Accuracy: | NRT100 | 2.0 µm |
| | NRT150 | 2.0 µm |
| Pitch: | 0.008° (140 µrad) | |
| Yaw: | 0.05° (873 µrad) | |
| Construction: | Aluminum with precision, recirculating linear bearings. | |

* The velocity quoted above is only achievable with light loads. When using heavy loads, the velocity should be reduced accordingly.

## 4.2 Motor Specification

| | |
|---|---|
| Step Angle: | 1.8°<br>(50 poles and ±2 phases for 360° divided by 200, or 1.8°) |
| Step Accuracy: | 5% |
| Rated Phase Current: | 1A |
| Phase Resistance: | 4.6 Ω |
| Phase Inductance: | 10.6mH |
| Holding Torque: | 23.1N.cm |
| Detent Torque: | 1.7N.cm |
| Phase Inductance: | 10.6mH |
| Operating Temperature: | -20°C to +40°C (Motor Specification Only) |




| | |
|---|---|
| 1 | Limit Switch Ground |
| 2 | O/P Positive (End) Limit Switch |
| 3 | O/P negative (Home) Limit Switch |
| 4 | PH B -ve |
| 5 | PH B +ve |
| 6 | PH A -ve |
| 7 | PH A +ve |
| 13 | Limit Switch +5V |
| 15 | Ground/Earth |

**Fig. 4.1 Motor pin out details**

## 4.3 Parts List

| Part Number | Description |
|---|---|
| PAA612 | Connection Cable 1 m (3.3') |
| PAA613 | Connection Cable 3 m (9.8') |
| NRT100 and NRT100/M | NanoStep NRT stage with 100mm travel |
| NRT150 and NRT150/M | NanoStep NRT stage with 150mm travel |
| NRT150P1 | 'Z' bracket for fixing stages in X-Z, Y-Z and X-Y-Z configurations |
| ha0136T | Handbook |

# Chapter 5 Regulatory

## 5.1 Declarations Of Conformity

### 5.1.1 For Customers in Europe

This equipment has been tested and found to comply with the EC Directives and standards:

Electrical Equipment for measurement, control and laboratory use - EMC requirements - EN61326-1, 2006

Safety of machinery. General principles for design. Risk assessment and risk reduction - EN ISP 12100, 2010

Machinery Directive (MD) - 2006/42/EC

Electromagnetic Compatibility (EMC) - 2004/108/EC

Restriction of use of certain hazardous substances (RoHS)" - 2011/65/EU

Waste electrical and electronic equipment (WEEE)" - 2002/96/EC

E.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.

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

### 5.2.1 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

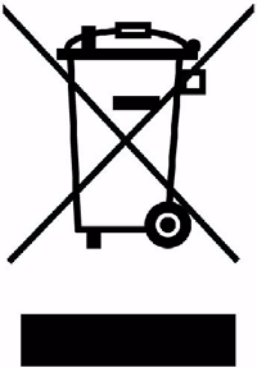


**Fig. 5.1 Crossed out "wheelie bin" symbol**

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.

### 5.2.2 Waste treatment on your own responsibility

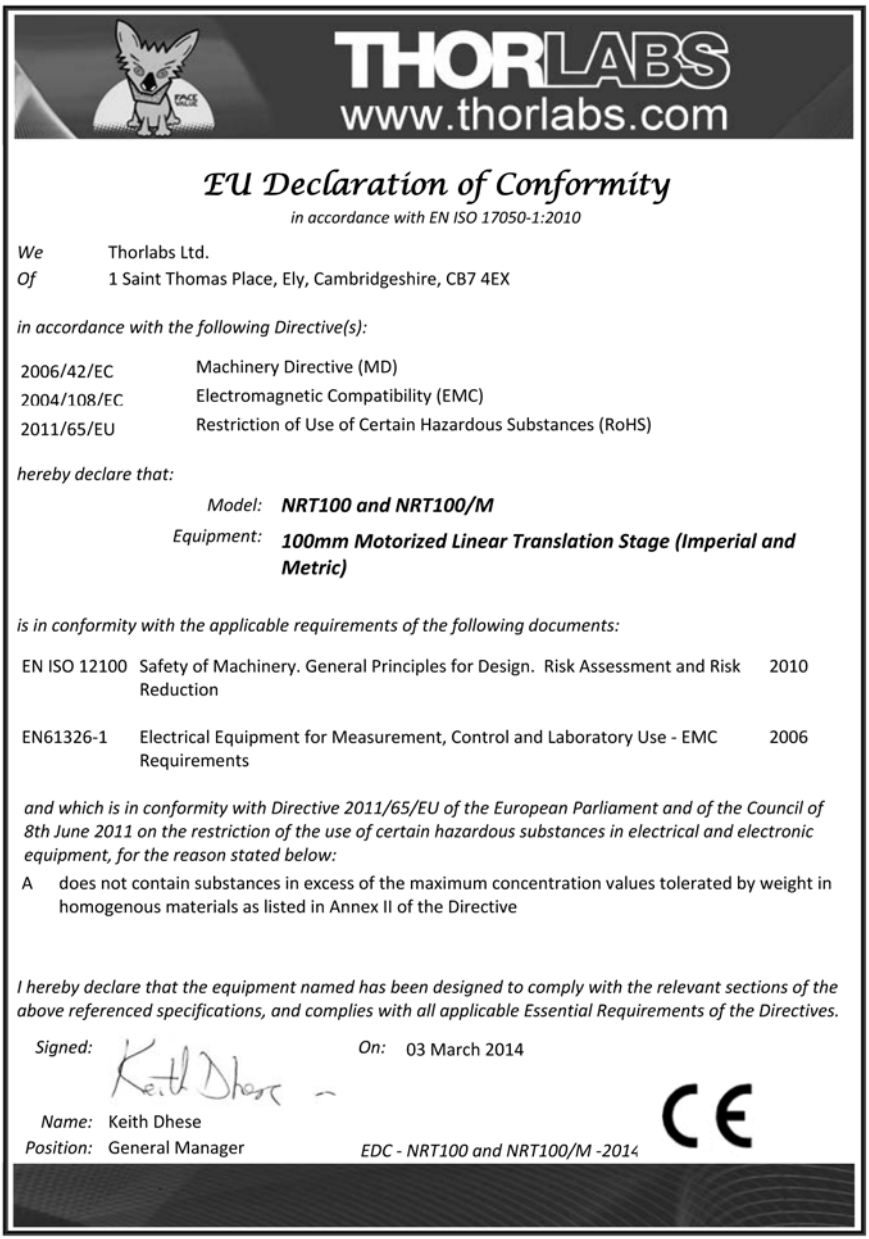
If you do not return an "end of life" unit to the company, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

### 5.2.3 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.

## 5.3 CE Certificate



THORLABS
www.thorlabs.com

# EU Declaration of Conformity

*in accordance with EN ISO 17050-1:2010*

*We* Thorlabs Ltd.
*Of* 1 Saint Thomas Place, Ely, Cambridgeshire, CB7 4EX

*in accordance with the following Directive(s):*

| | |
|---|---|
| 2006/42/EC | Machinery Directive (MD) |
| 2004/108/EC | Electromagnetic Compatibility (EMC) |
| 2011/65/EU | Restriction of Use of Certain Hazardous Substances (RoHS) |

*hereby declare that:*

*Model:* ***NRT100 and NRT100/M***

*Equipment:* ***100mm Motorized Linear Translation Stage (Imperial and Metric)***

*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 |
| EN61326-1 | Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements | 2006 |

*and which 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:*

A 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

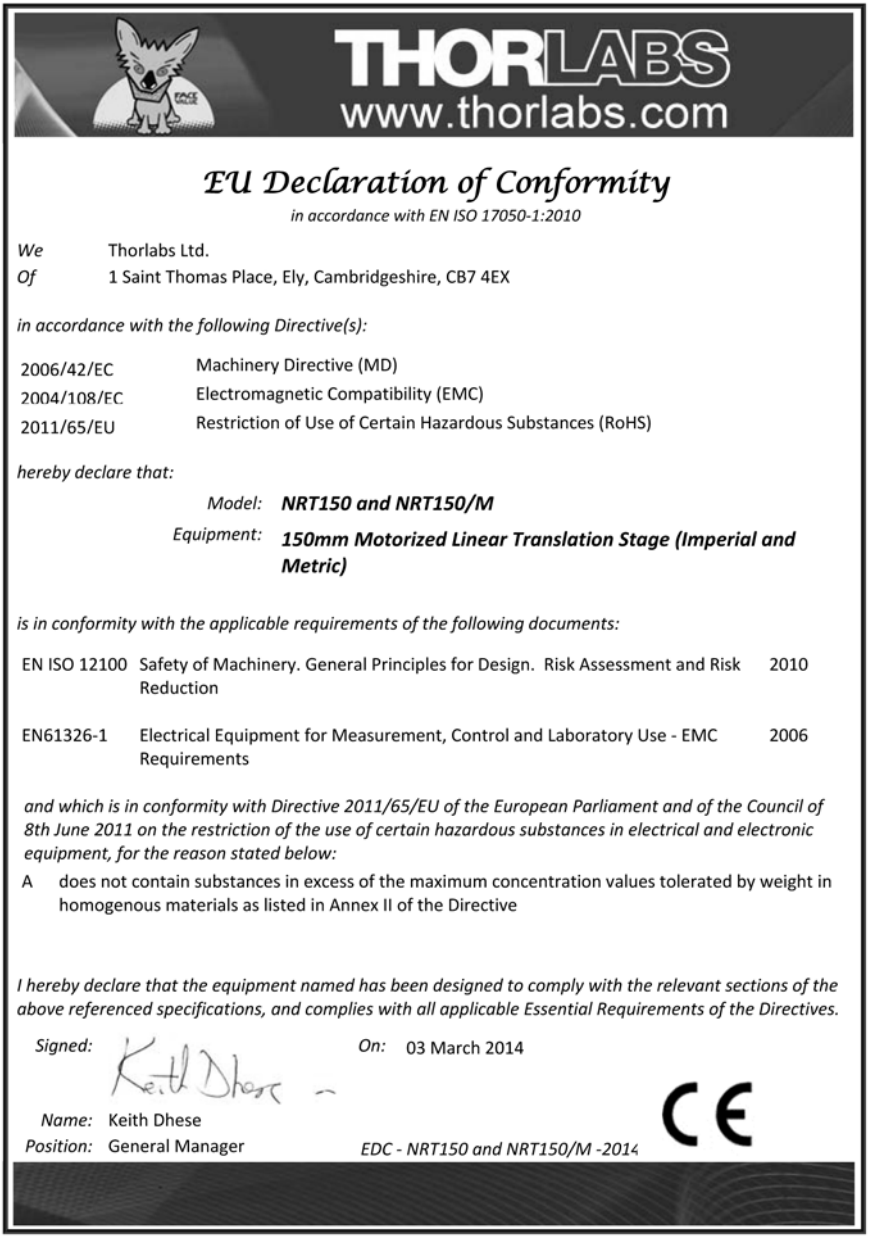
*I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.*

*Signed:* Keith Dhese *On:* 03 March 2014

*Name:* Keith Dhese
*Position:* General Manager

CE

*EDC - NRT100 and NRT100/M -2014*



THORLABS
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# EU Declaration of Conformity

*in accordance with EN ISO 17050-1:2010*

*We* Thorlabs Ltd.
*Of* 1 Saint Thomas Place, Ely, Cambridgeshire, CB7 4EX

*in accordance with the following Directive(s):*

| | |
|---|---|
| 2006/42/EC | Machinery Directive (MD) |
| 2004/108/EC | Electromagnetic Compatibility (EMC) |
| 2011/65/EU | Restriction of Use of Certain Hazardous Substances (RoHS) |

*hereby declare that:*

*Model:* ***NRT150 and NRT150/M***

*Equipment:* ***150mm Motorized Linear Translation Stage (Imperial and Metric)***

*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 |
| EN61326-1 | Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements | 2006 |

*and which 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:*

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*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:* Keith Dhese *On:* 03 March 2014

*Name:* Keith Dhese
*Position:* General Manager

CE

*EDC - NRT150 and NRT150/M -2014*

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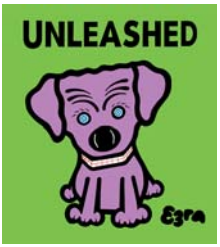


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