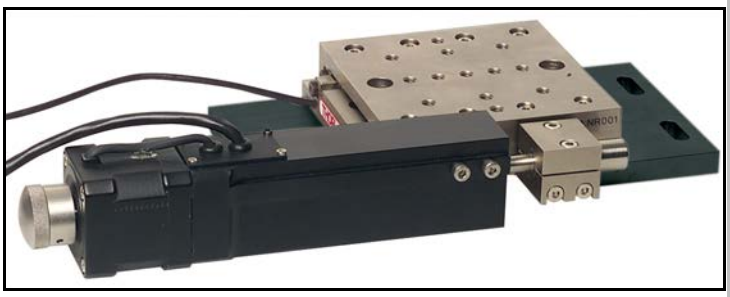
THORLABS

LNR50 Series
Encoded, Linear, Long-travel
Translation Stage

User Guide



Original Instructions

Contents

Chapter 1 Overview

1.1 Linear Long-travel Translation Stage

1.1.1 Introduction

The TravelMax single-axis linear long travel stage has been designed to integrate seemlessly into the Thorlabs modular electronic or benchtop nanopositioning systems, with the added functionality of encoder validated position reporting.

The APT Server includes full support for encoded position feedback. We manufacture a number of linear encoded equipped stage/actuator combinations with associated electronics and cabling in order to connect to the APT range of stepper controller units (both bench top and modular rack variants).

Combining the TravelMax stage with an integrated optical encoder provides the ideal solution for when stability, long travel and high load capacity need to be coupled with absolute position accuracy. The TravelMax LNR50E features a sub-micron resolution position linear scale that is attached to the moving platform of the stage. The encoder reads this scale to provide the feedback to ensure true nanopositioning capabilities. This means that mechanical positioning errors, such as backlash, can be ignored.

This combination of long-travel actuator and a high-precision optical encoder provides solutions to applications such as manipulation, alignment and assembly of photonics products, and microscope examination of large samples.

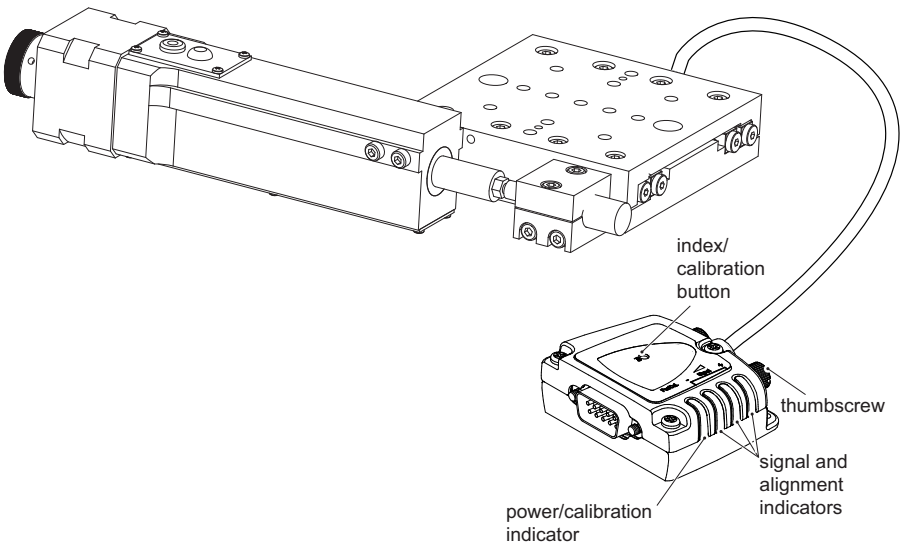


Fig. 1.1 TravelMax LNR50E linear long travel stage with optical encoder

Stages can be bolted together in an XY or XYZ configuration for applications where movement is required in more than one axis.

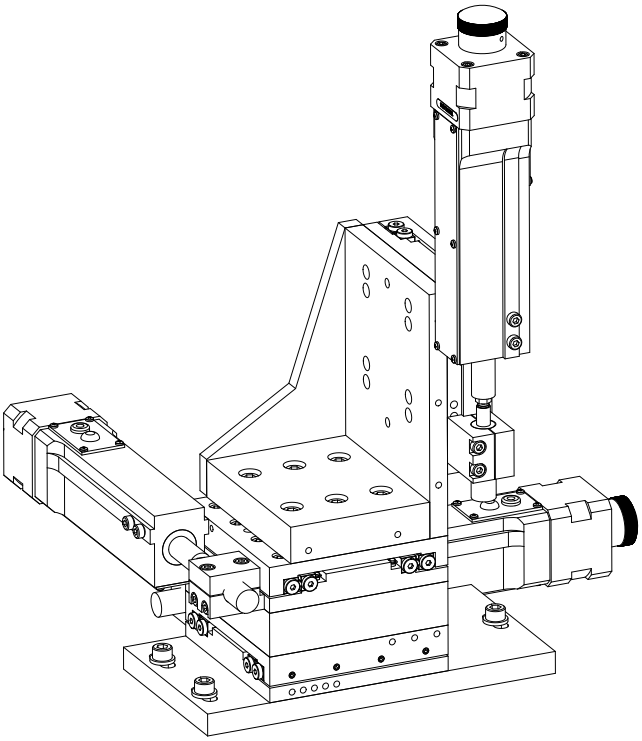


Fig. 1.2 Typical XYZ configuration

1.1.2 Drives

The stage is shipped complete with our DRV014 trapezoidal stepper motor drive. The piezo drives and manual drives advertised on our web site for use with the LNR50 stage are not compatible with the LNR50SE encoded stage version.

Note

The DRV014 trapezoidal stepper motor drive must be used in conjunction with the BSCxxx or MST60x series stepper motor controllers.

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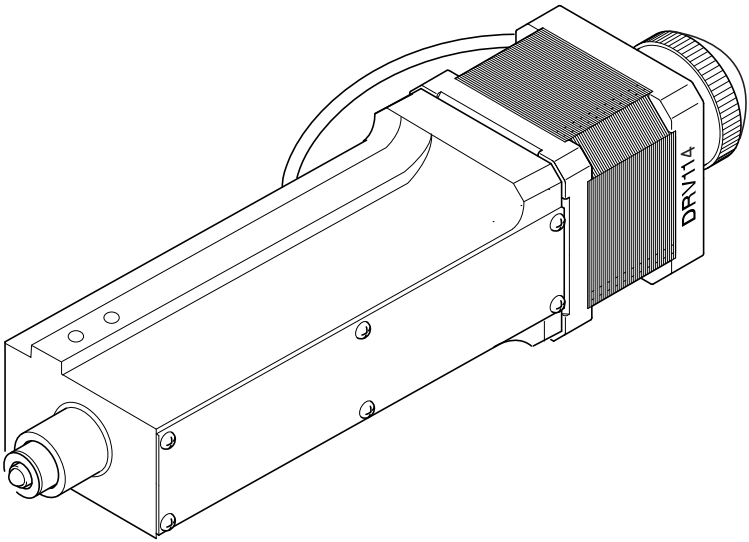

Fig. 1.3 A typical stepper motor drive

Chapter 2 Safety

2.1 Safety Information

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

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

Warning: Risk of Electrical Shock

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

Warning

Given when there is a risk of injury to users.

Caution

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

Note

Clarification of an instruction or additional information.

2.2 General Warnings

Warning

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

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

The equipment is for indoor use only.

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 3 Installation

3.1 Unpacking

Note

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

Caution

Once removed from its packaging, the stage is easily damaged by mishandling.

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.

3.3 Mounting

3.3.1 General

The LNR50 series stages are mounted to the work surface as shown using a base plate. For additional versitility, an angle bracket is available for use in vertical mounting configurations - see Section 3.3.4. When mounting the stage close to other equipment, ensure that the travel of the moving platform is not obstructed. If equipment mounted on the moving platform is driven against a solid object, damage to the internal mechanism could occur.

The range of travel on each axis is 50 mm total, that is ± 25 mm about the nominal position.

The stage is shipped with the drives configured for right handed use, however they can be repositioned for applications where left handed use is more convenient - see Section 3.5. for more details.

Caution

When mounting components, or fitting the stage within an application, do not apply excessive pressure to the moving platform as this may damage the bearing mechanism.

Note

The LNR series stages can quickly be assembled into XY, XZ, YZ and XYZ configurations - see Section 3.3.3. and Section 3.3.4. The brackets and plates are supplied complete with dowels, which ensure an accurate, orthogonal assembly.

3.3.2 Mounting to the Work Surface

Referring to Fig. 3.1, proceed as follows:

1) Turn the motor knob to position the moving carriage central in its range of travel, and ensure that the mounting holes in the base are clearly visable through the holes in the top plate.
2) Fit the dowels supplied to the base plate (LNR50P1).
3) Position the stage on the base plate, ensuring that the dowels locate correctly in the holes in the lower surface of the stage.
4) Fit two bolts (M6 x 12 or 1/4-20 x 1/2", not supplied) through the holes in the top plate and into the base plate. Tighten to secure the stage in place.

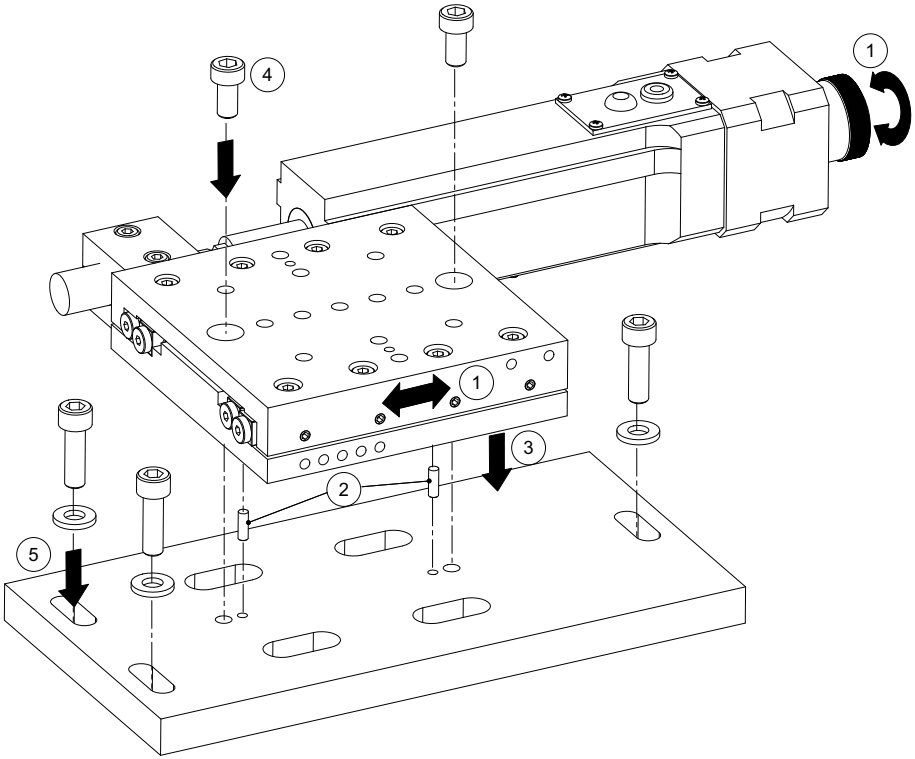

Fig. 3.1 Fitting the base plate

5) Fit three bolts (M6 or 1/4-20, not supplied) through each end of the base plate to fix the stage to the work surface.
6) To remove the base plate, reverse the procedure above.

3.3.3 Building an XY Configuration

Bolt the X-axis stage to the work surface as detailed in Section 3.3.2. then, referring to Fig. 3.2, proceed as follows:

1) Fit the dowels supplied to the moving platform of the lower stage.
2) Fit the spacer plate (LNR50P3) into place as shown below, ensuring that the dowels in the lower stage locate correctly in the holes in the bottom surface of the spacer plate.
3) Fit a bolt (M6 x 12 or 1/4-20 x 1/2", not supplied) through the hole in the center of the spacer plate and into the top platform of the lower stage. Tighten the bolt to secure the plate in position.

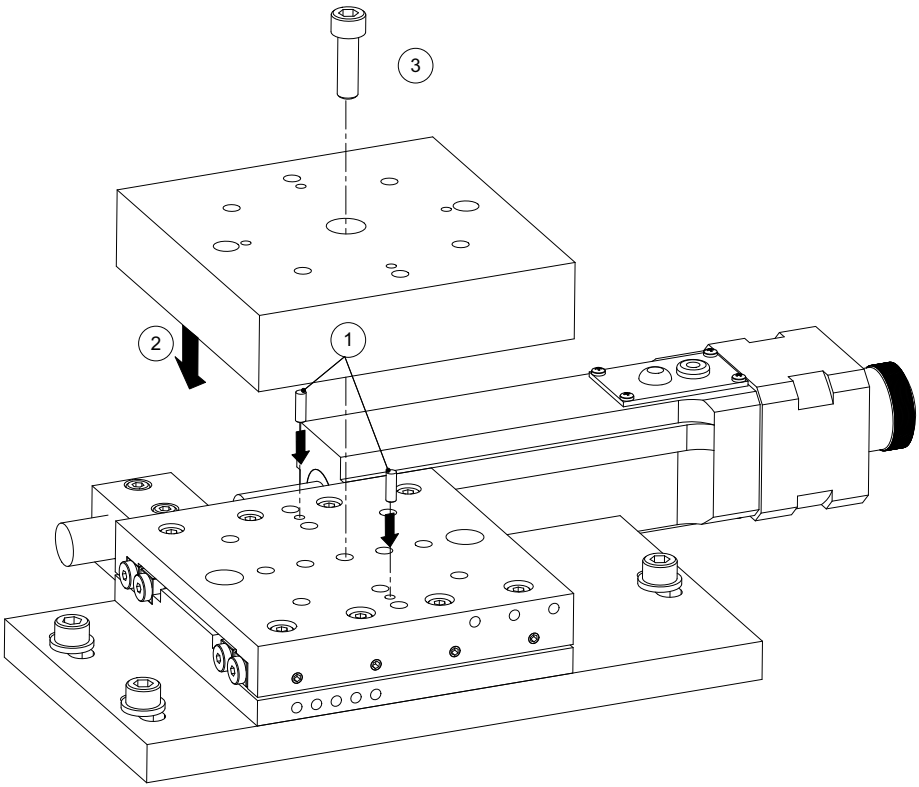

Fig. 3.2 Fitting a Spacer Plate

4) Fit the dowels supplied to the top surface of the spacer plate.
5) Fit the Y-axis stage into place ensuring that the dowels in the spacer plate locate correctly in the holes in the lower surface of the stage.
6) Fit two bolts (M6 x 12 or 1/4-20 x 1/2", not supplied) through the holes in the upper stage and tighten to secure the stage to the spacer plate beneath.

Caution

Use only bolts of the stated length. Longer bolts will protude into the stage and damage the internal mechanism.

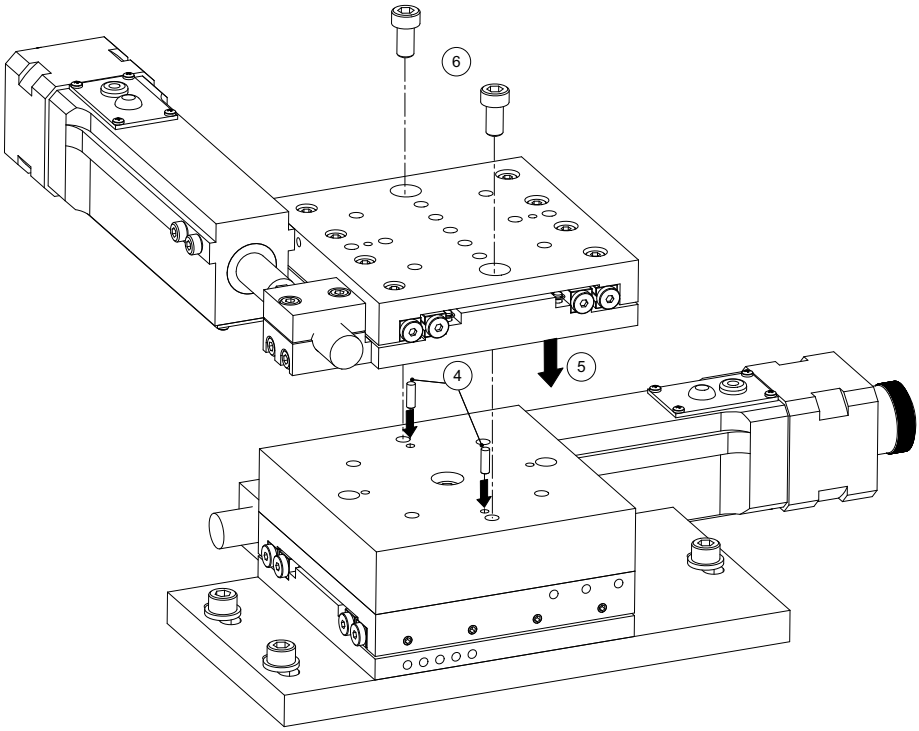

Fig. 3.3 Fitting the Y-Axis Stage

3.3.4 Building an XYZ Configuration

Assemble an XY configuration as detailed in Section 3.3.3. then, referring to Fig. 3.4, and Fig. 3.5 proceed as follows:

1) Fit the dowels supplied, into the moving platform on the upper stage of the XY assembly.
2) Fit the angle bracket (LNR50P2) onto the moving platform of the stage, ensuring that the dowels fitted at item (1) locate correctly in the holes on the underside of the angle bracket..

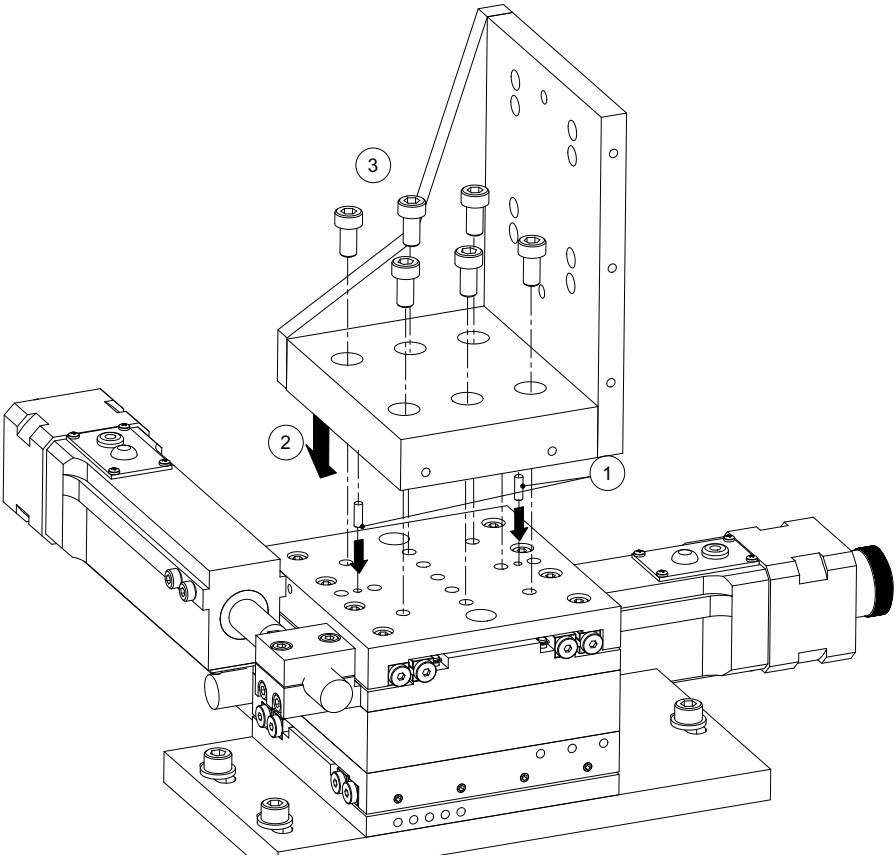

Fig. 3.4 Fitting the Angle Bracket

3) Fit six bolts (M6 x 16 or 1/4-20 x 5/8", not supplied), through the holes in the base of the angle bracket, and tighten to secure the bracket to the XY assembly.

Caution

Use only bolts of the stated length. Longer bolts will protude into the stage and damage the internal mechanism.

4) Fit the dowels supplied into the holes in the back surface of the angle bracket.
5) Fit the vertical-axis stage into place ensuring that the dowels fitted at item (4) locate correctly in the holes on the underside of the stage.
6) Fit two bolts (M6 x 12 or 1/4-20 x 1/2", not supplied), through the holes in the top plate, and screw into the rear face of the angle bracket.

Caution

Use only bolts of the stated length. Longer bolts will protude into the stage and damage the internal mechanism.

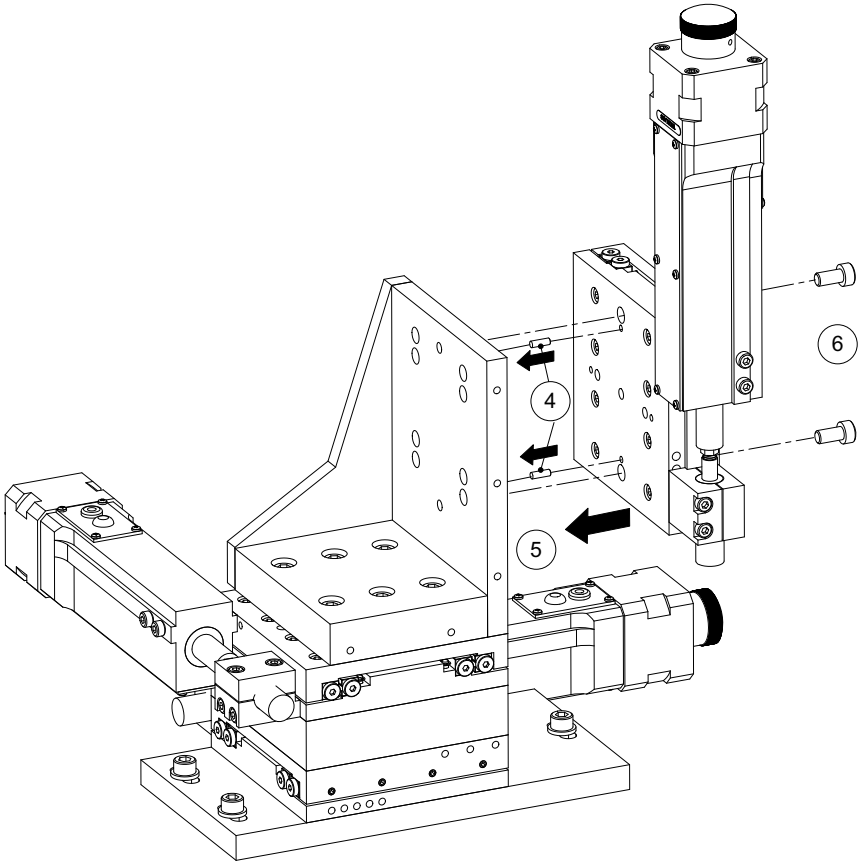

Fig. 3.5 Adding a Vertical Axis Stage

3.4 Fitting and Removal of Drives

1) Remove the motor mounting bolts.
2) Remove the exisiting drive.
3) Fit the replacement drive.
4) Refit the motor mounting bolts.

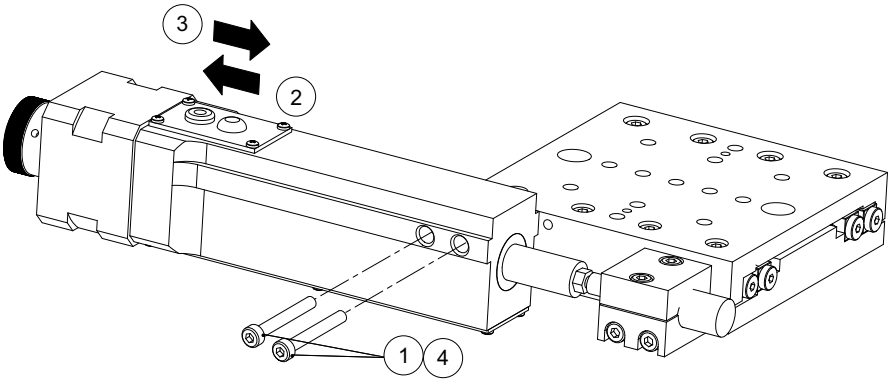

Fig. 3.6 Fitting/removing a motor drive

3.5 Reconfiguring the Actuator Position

The stage is shipped with the drives configured for a right handed configuration, however they can be repositioned for left handed use. This is achieved by swapping the position of the actuator clamp and the push block as follows:

Referring to Fig. 3.7:

1) Remove the actuator as detailed in Section 3.4.
2) Loosen the push block pinch bolts.
3) Remove the push block.
4) Undo the push block mounting bolts and remove the push block mounting block.

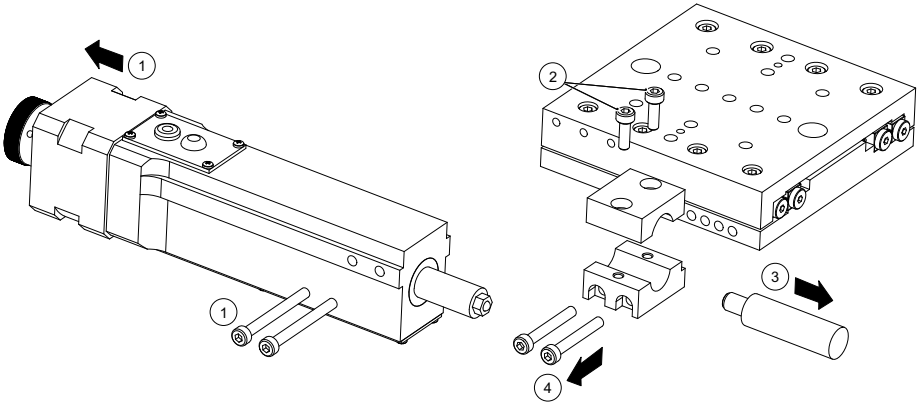

Fig. 3.7 Removing the Actuator Clamp and Push Block

Referring to Fig. 3.8 on the next page:

5) Refit the push block mounting block on the opposite side of the stage as shown in Fig. 3.8 and tighten the attachment bolts.
6) Refit the push block pinch bolts but do not tighten.
7) Refit the push block, then tighten the push block pinch bolts.
8) Refit the motor actuator, and tighten the mounting bolts.
9) Turn the motor knob until 25 mm of drive shaft is protruding.
10) Loosen the push block pinch bolts and position the push block such that the stage is in its center of travel.
11) Tighten the push block pinch bolts.

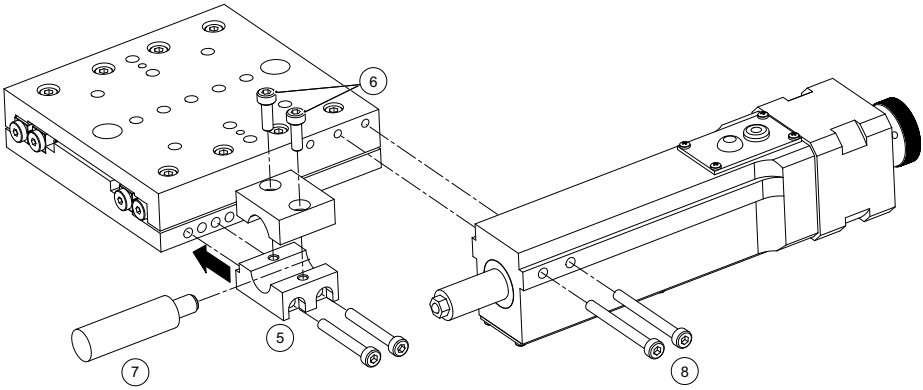

Fig. 3.8 Reconfiguring the Actuator Position

3.6 Connecting The Hardware

1) Perform the mechanical installation as detailed in Section 3.
2) Install the APT Software - see the handbook supplied with your stepper motor controller.

3) Using the splitter lead supplied, connect the stage to the Controller unit and SmartSignal module as shown in Fig. 3.9.

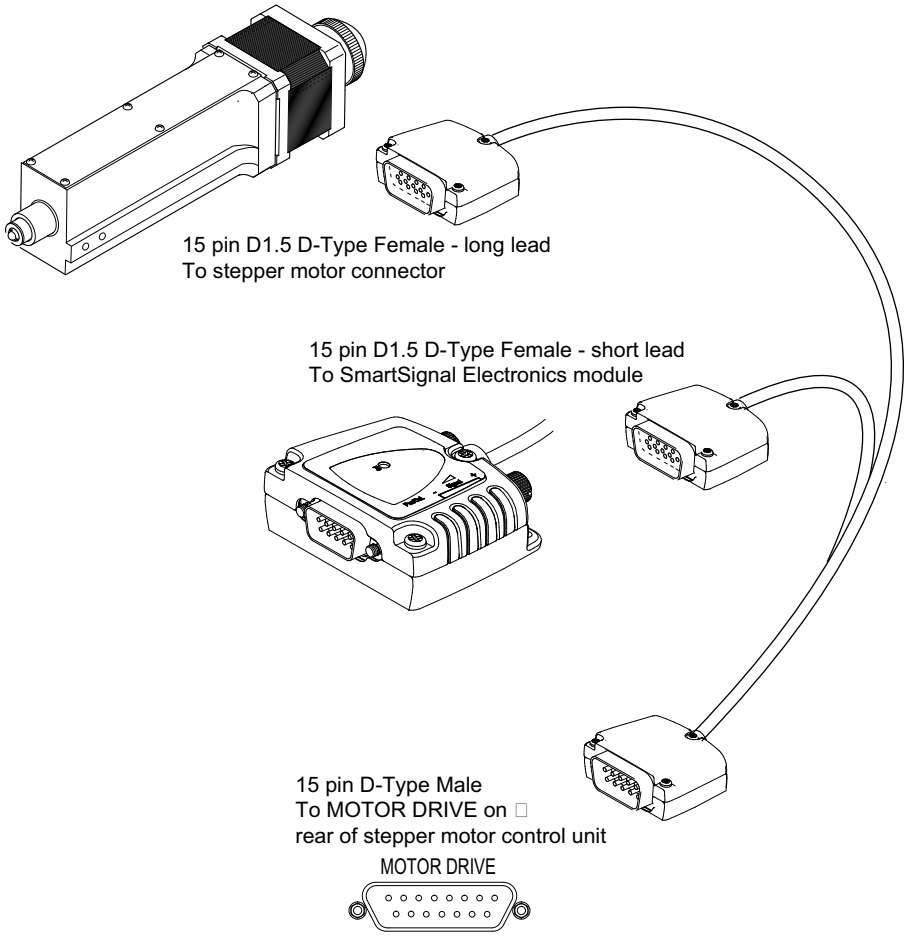

Fig. 3.9 Electrical connections

4) Connect the Controller unit to the main power supply and switch ON
5) Connect the Controller unit to your PC..

Note

The USB cable should be no more than 3 metres in length. Communication lengths in excess of 3 metres can be achieved by using a powered USB hub)

6) Windows™ should detect the new hardware. Wait while Windows™ installs the drivers for the new hardware.

Chapter 4 Operation

Note

The TravelMax encoded stage incorporates a linear encoder sensor and a SmartSignal electronics module, designed by MicroE Systems. When the TravelMax is driven by a Thorlabs stepper motor actuator, all programmable and diagnostic features are enabled via the APT server software, and the following procedures assume that a Thorlabs DRV014 actuator is fitted (i.e. as shipped with the LNR50SE).

If the TravelMax is to be used with a manual drive or piezo actuator, then an RS232 Interface Adapter and additional 'SmartSignal' software are required before the encoder functionality can be enabled. These are available directly from MicroE Systems.

4.1 Encoder Calibration Check

Calibration of the encoder is performed at the factory during manufacture. The following calibration check should be performed if the SmartSignal electronics module is replaced, or when the accuracy of the system is in doubt. If the calibration check cannot be performed satisfactorily, the unit should be returned to the factory for recalibration.

1) Perform the installation, electrical connection and stage association procedures as detailed in Section 3.
2) Position the stage at least 7mm (1/4 in.) away from its mid point.
3) Insert a small diameter, non-metalic shaft (e.g. plastic paper clip) into the hole in the casing and push the Calibration button - see Fig. 4.1. The Power/Calibration LED flashes continuously.
4) Move the stage backwards and forwards over its mid point until the Power/ Calibration LED stops flashing.
5) Move the actuator over its complete range of travel. The green 'Proper Alignment' LED should remain lit. If the yellow or red LEDs light, see Troubleshooting, Section 4.4.

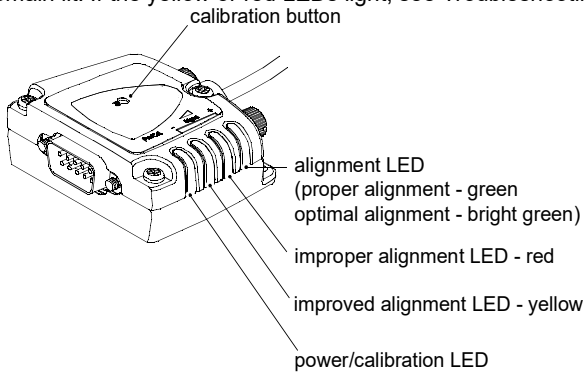

Fig. 4.1 Calibration indicators

4.2 Selecting the Stage Type

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 automatically applies 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. 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. If using Kinesis software, see Section 4.2.1. if using APT, see Section 4.2.4.

4.2.1 Using Kinesis Software

Caution

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

1) Install the electronic hardware and connect the modules to the relevant axes of the associated stages (see the handbooks for the associated controller).
2) For each Stepper Motor Controller in your system, fit the interlock plug (supplied) to the MOTOR CONTROL connector on the rear panel.
3) Ensure that the device is connected to the PC and powered up.
4) Run the Kinesis software - Start/All Programs/Thorlabs/Kinesis/Kinesis.
5) On start-up, the 'Actuator/Startup Settings' window is displayed. This window allows the correct actuator to be selected.

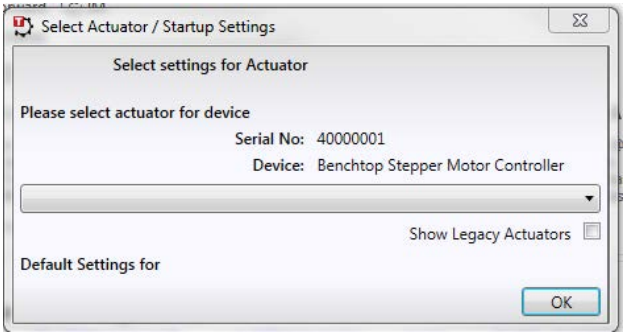

Fig. 4.2 Select Actuator Settings Window - 1

6) Click the arrow on the right hand side of the drop down box and select LNR50SE from the list displayed.

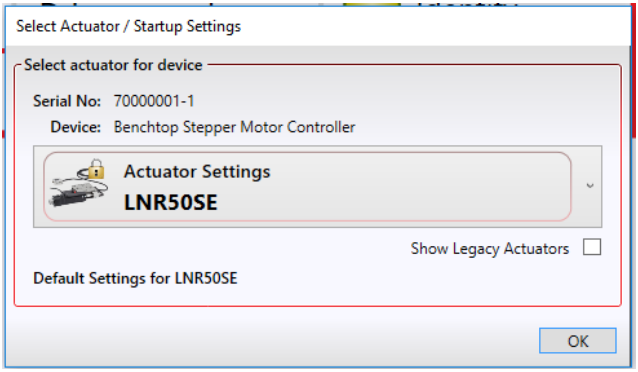

Fig. 4.3 Select Actuator Settings Window - 2

7) Click OK.
8) 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.

4.2.2 Selecting Encoder Support in Kinesis

When an encoded stage type has been associated with a motor channel (see Section 4.2.1.), encoder feedback support (both GUI and programmable interfaces) is enabled by selecting 'Closed Loop' in the corresponding Kinesis Control.

1) Run the Kinesis software, then click the Settings button.

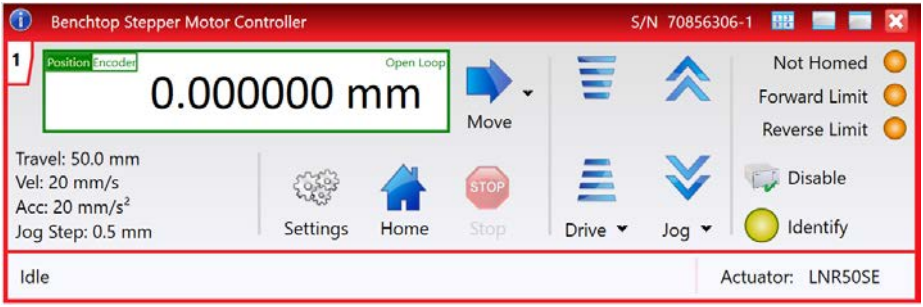

Fig. 4.4 Kinesis Motor GUI panel

2) Select the Advanced tab.

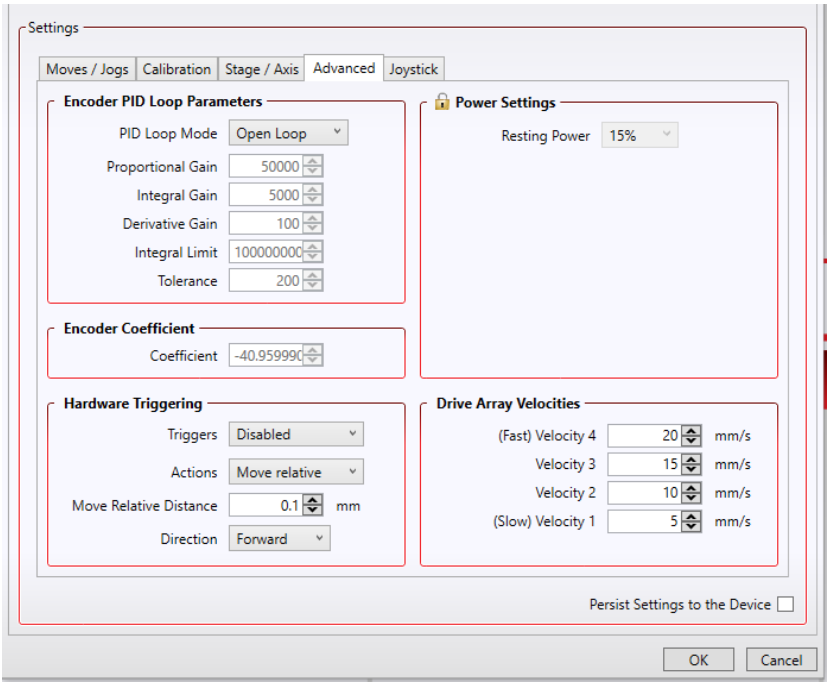

Fig. 4.5 Settings - Advanced tab

3) In the *PID Loop Mode* field, select Closed Loop.
4) Encoder feedback is now enabled.

When Closed Loop is selected, the motion processor within the controller uses a position control loop to determine the motor command output. The purpose of the position loop is to match the actual motor position and the demanded position. This is achieved by comparing the demanded position with the actual position to create a position error, which is then passed through a digital PID-type filter. The filtered value is the motor command output.

The default PID parameters should be sufficient for most applications, but these can be fine tuned to improve performance as required by creating Custom settings - see the manual for the associated controller and also the Kinesis helpfile for further information on creating custom settings.

The parameters on the settings panel are described as follws:

Proportional Gain - Together with the Integral and Differential, these terms determine the system response characteristics and accept values in the range 0 to 16777216.

Integral Gain - Together with the Proportional and Differential, these terms determine the system response characteristics and accept values in the range 0 to 16777216.

Differential Gain - Together with the Proportional and Integral, these terms determine the system response characteristics and accept values in the range 0 to 16777216.

Integral Limit - This parameter is used to cap the value of the PID loop to prevent runaway at the output. It accepts values in the range 0 to 16777216. If set to 0 then the output of the PID loop is ignored.

Tolerance - Value below which the output of PID generator is effectively deemed to be zero to avoid continual cycle about set point

Encoder Coefficient - This is a conversion factor from Encoder counts to microsteps for the specific stage and controller being used. For the BSC series controllers and LNR50SE stage, the value is 4292282941. If set to 0, then no encoder is fitted to the stage.

4.2.3 Calculating the EncoderConst Value

Each stage has a specific constant for converting encoder counts to microsteps. For the LNR50SE stage, this value is 4292282941.

For example

Encoder resolution = 100 nm

Stepper resolution = 409600 microsteps/turn/mm

= 2.44 nm per step

Therefore no. of µsteps per encoder count = 100 nm/2.44 = 40.96.

The chip inside the controller uses 16.16 bit format, where 16 bits represent the integer and 16 bit are for the fraction.

Interger part 40 = Hex28 = 0X0028

Fraction part 0.96/1/65536 = 62914.56 = F5C3

Therefore EncoderConst value = 0028F5C3

For negative values, we must find the 2s compliment value…

28F5C3 = 0000 0000 0010 1000.1111 0101 1100 0011

2s comp = 1111 1111 1101 0111.0000 1010 0011 1100 + 1

= FFD7.0A3D

4.2.4 Using APT Software

Caution

To use this functionality, the controller must be installed with firmware V3.0.6 or higher. To access encoder functionality in older firmware units, see Chapter 7.

1) Install the electronic hardware and connect the modules to the relevant axes of the associated stages (see the handbooks for the associated controller).
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.

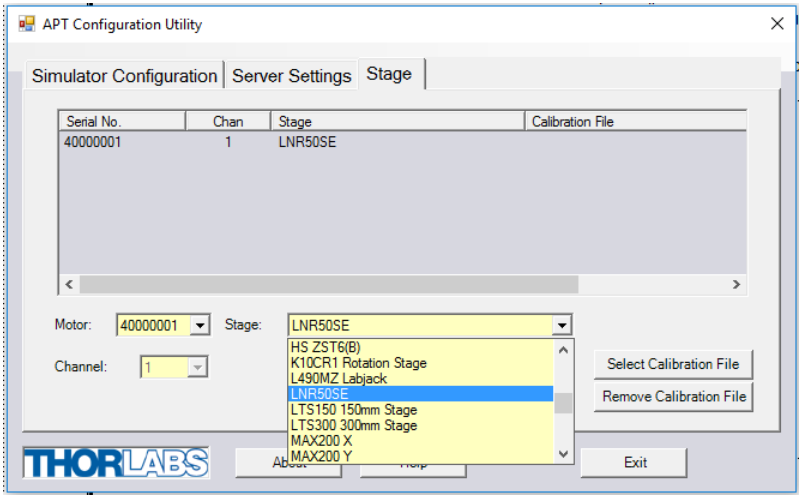

Fig. 4.6 APT Configuration Utility - Stage Tab

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 and axis type as described above. Selecting an incompatible stage/axis type could result in reduced velocity and resolution.

7) In the ‘Stage’ field, select the type of stage LNR50SE from the list, then click the 'Add/Change Stage Association' button.
8) 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.

4.2.5 Selecting Encoder Support in APT

When an encoded stage type has been associated with a motor channel (see Section 4.2.4.), encoder feedback support (both GUI and programmable interfaces) is enabled by selecting 'Closed Loop' in the corresponding Motor ActiveX Control.

1) Run the APTUser utility, then click the Settings button displayed at the bottom right of the panel.

Fig. 4.7 Motor GUI panel with encoder button

2) Select the Control Loop tab.

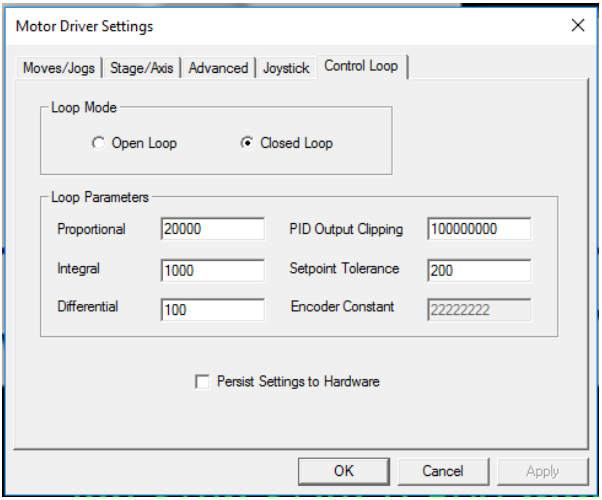

Fig. 4.8 Settings - Control Loop tab

3) In the Loop Mode field, select Closed Loop.

4) Encoder feedback is now enabled. The default PID parameters should be sufficient for most applications, but these can be fine tuned to improve performance as required.

When Closed Loop is selected, the motion processor within the controller uses a position control loop to determine the motor command output. The purpose of the position loop is to match the actual motor position and the demanded position. This is achieved by comparing the demanded position with the actual position to create a position error, which is then passed through a digital PID-type filter. The filtered value is the motor command output.

The parameters on the settings panel are described as follws:

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Integral gain - Together with the Proportional and Differential, these terms determine the system response characteristics and accept values in the range 0 to 16777216.

Differential gain - Together with the Proportional and Integral, these terms determine the system response characteristics and accept values in the range 0 to 16777216.

PID Output Clipping - This parameter is used to cap the value of the PID loop to prevent runaway at the output. It accepts values in the range 0 to 16777216. If set to 0 then the output of the PID loop is ignored.

Setpoint Tolerance - Value below which the output of PID generator is effectively deemed to be zero to avoid continual cycle about set point

Encoder Constant - This is a conversion factor from Encoder counts to microsteps. If set to 0, then no encoder is fitted to the stage.

4.2.6 Calculating the EncoderConst Value

Each stage has a specific constant for converting encoder counts to microsteps. For the LNR50SE stage, this value is 4292282941.

For example

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For negative values, we must find the 2s compliment value…
28F5C3 = 0000 0000 0010 1000.1111 0101 1100 0011
2s comp = 1111 1111 1101 0111.0000 1010 0011 1100 + 1
= FFD7.0A3D

4.3 Mounting Equipment to the Stage

Caution
The weight attached to the moving platform must not exceed 10 kg.
Do not apply excessive forces to the moving platform.

Thorlabs manufacture a variety of fibre chucks, holders and fixtures to fit the linear stage. All of these accessories are mounted to the stage via a top platform, see Fig. 4.9.

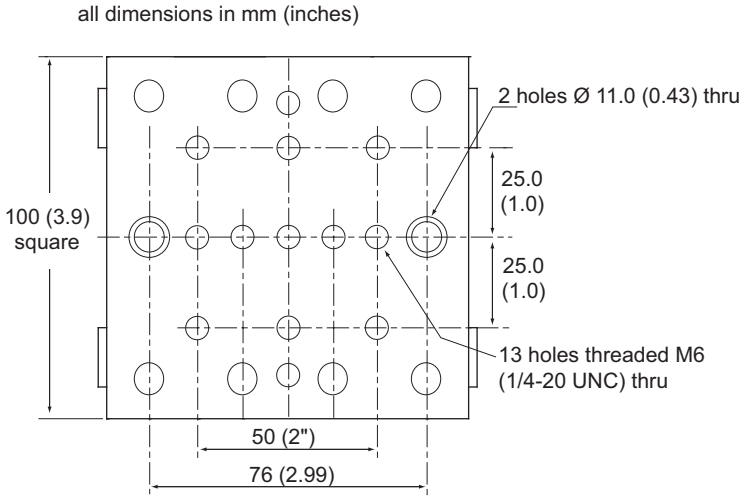


Fig. 4.9 Top platform

4.4 Troubleshooting

The green Power/Calibration indicator will not come on, the red or yellow indicators may be lit.

Ensure that the SmartSignal electronics' 15-pin D-sub connector is fully seated and connected.

The green, 'Proper Alignment' indicator doesn't stay illuminated over the full length of travel, the red or yellow indicators may be lit.

Verify that the mid point of the actuator travel has been correctly aligned to the midpoint of the stage travel.

Ensure that the encoder scales are clean over their entire length - see Section 4.6.

The green Power/Calibration indicator is flashing.

The 'SmartSignal electronics' Index/Calibration process is activated by pressing the recessed button in the SmartSignal electronics' connector body. When this button is pressed, the Power/Calibration LED will flash until the internal sensor passes over the midpoint of the stage at least once in each direction.

If after performing the above checks the problem persists, the unit should be returned to the factory for investigation.

4.5 Preventive Maintenance

Warning

The equipment contains no user servicable parts. There is a risk of severe electrical shock if the equipment is operated with the covers removed. Only personnel authorized by Thorlabs Ltd and trained in the maintenance of this equipment should attempt any repairs or adjustments. Maintenance is limited to scleaning as described in the following sections.

4.6 Cleaning

To ensure trouble free operation, periodic cleaning of the encoder scales is advised. Frequency depends upon usage and environment.

1) Invert the stage, and push the moving platform to one end of its travel. Part of the encoder scale is now accessible.
2) Blow off any loose particles with an aerosol air duster. Pay particular attention to the unexposed portion of the scale.
3) Move the platform to its opposite end of travel and repeat item (2).
4) If problems persist, the scale may be cleaned with an optical wipe, dampened with isopropyl alcohol or acetone. Use only products described as 'suitable for cleaning optical components'. These can be obtained from stockists such as RS Components. Do not scrub the scale.

4.7 Transportation

Caution

The drives should be removed before transporting the stage.

When packing the unit for shipping, use the original packing.

If this is not available, use a strong box and surround the stage with at least 100 mm of shock absorbent material.

Chapter 5 Specifications and Dimensions

5.1 Specifications

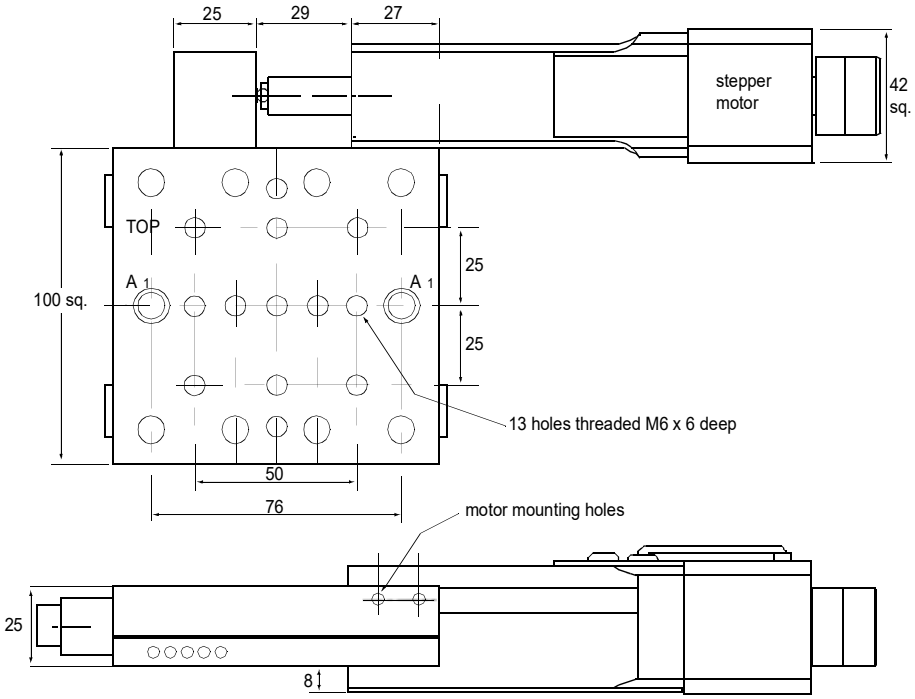
Parameter	Value
Travel Range	2" (50 mm)
Encoder	Optical Grating Incremental Encoder
Encoder Resolution	0.1 µm
Absolute On-axis Accuracy	3 µm Over The Full Travel
Bidirectional Repeatability	0.3 µm
Max Acceleration	20 mm/sec^2* (when used with BSC201 controller)
Max Velocity	20 mm/sec* (when used with BSC201 controller)
Velocity Stability	0.4 mm/sec
Backlash	<6 µm
Max Vertical Load Capacity	10 kg
Max Horizontal Load Capacity	22 kg (48.4 lb)
Min Acheivable Incremental Movement	0.05 µm
Max Percentage Accuracy	0.02 %
Home Location Accuracy	± 1.0 µm
Pitch	0.03°
Yaw	0.015°
Weight	2.82 kg
Drive	DRV014
Leadscrew Pitch	1 mm
Limit Switches	Ceramic Tipped Electro-Mechanical Switches
Recommended Controllers	Single Channel: BSC201 Three Channels: BSC203
Controller Interface	USB

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

5.2 Dimensions

5.2.1 TravelMax Linear Stage

all dimensions in mm



Note

2 holes ‘A’ (M6 or 1/4in.) 20mm clearance for mounting stages to tables or for X-Y and X-Y-Z configurations.

Spacer plates are required between and below stages when fitting stepper motor drives.

Fig. 5.1 Dimensions – TravelMax series linear stage (with stepper motor drive fitted)

5.2.2 SmartSignal Electronics Module

all dimensions in inches [mm]

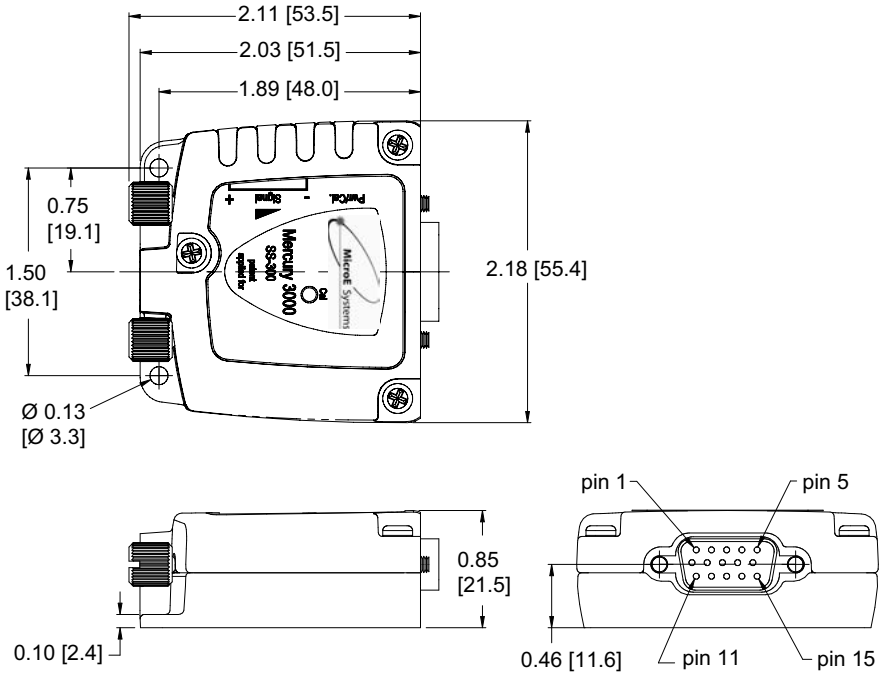


Fig. 5.2 Dimensions – SmartSignal electronics module

5.2.3 Motors

all dimensions in mm

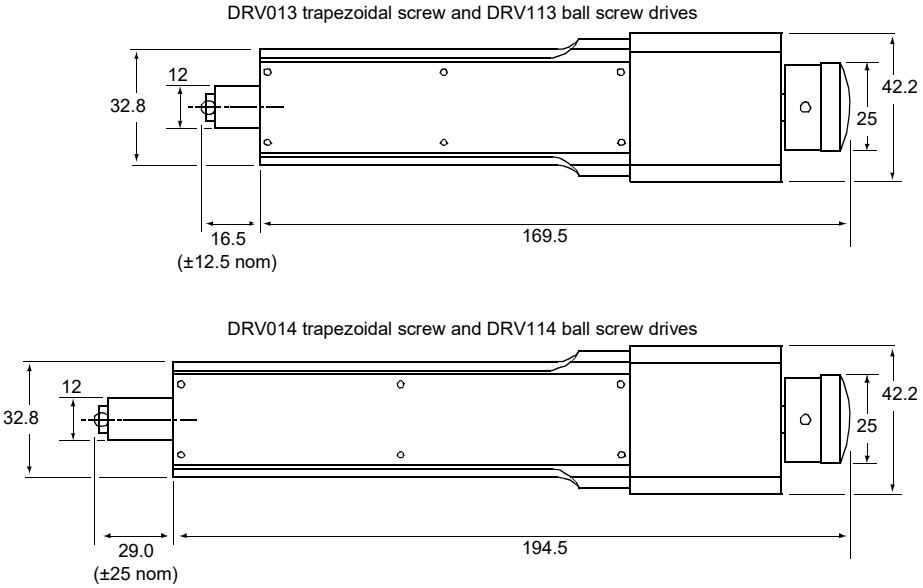


Fig. 5.3 Dimensions – stepper motor drives

Chapter 6 Parts List

Part Number	Description
Base plate	LNR50P1
Angle bracket	LNR50P2
Spacer (to allow x-y mounting)	LNR50P3
SMC connector lead	166038
LEMO connector lead	134667
Mounting cleat	131030
Cable clamp	120992
Handbook	ha0106T

Chapter 7 Operating Legacy Units

BSC20x units with firmware earlier than version 3.0.6 handle the encoder functionality in a different way to later units. This is described in the following sections.

7.1 Using Legacy Units with APT Software

1) Install the electronic hardware and connect the modules to the relevant axes of the associated stages (see the handbooks for the associated controller).
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.

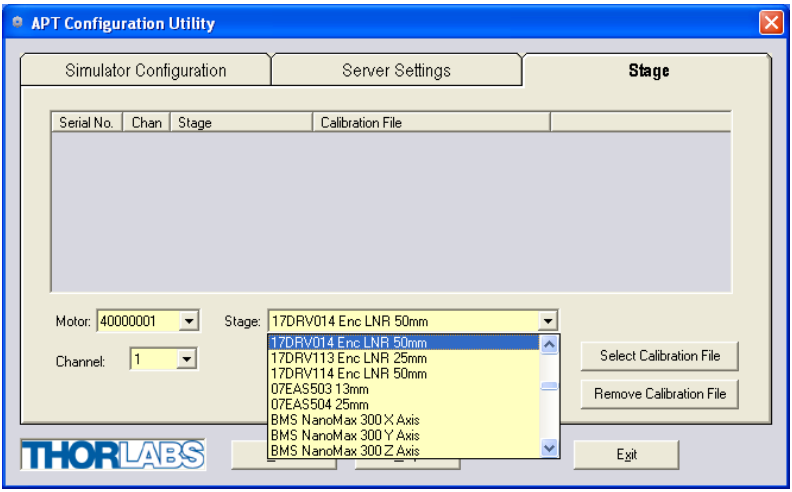


Fig. 7.1 APT Configuration Utility - Stage Tab

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 and axis type as described above. Selecting an incompatible stage/axis type could result in reduced velocity and resolution.

7) In the ‘Stage’ field, select the type of stage 17DRV014Enc LNR 50mm Click the 'Add/Change Stage Association' button.
8) 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.

7.2 Encoder Operation

7.2.1 Selecting Encoder Support

When an encoded stage type has been associated with a motor channel (see Section 4.2.4.), encoder feedback support (both GUI and programmable interfaces) is enabled in the corresponding Motor ActiveX Control.

1) Run the APTUser utility. On the main motor graphical panel an 'Encoder' button is displayed at the bottom left of the panel.

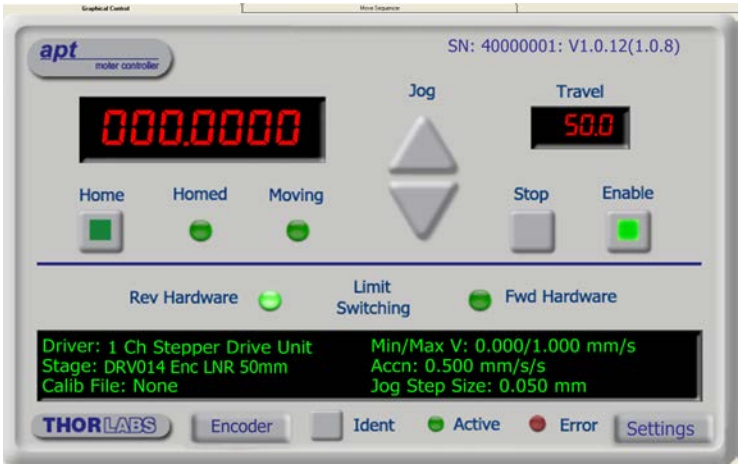
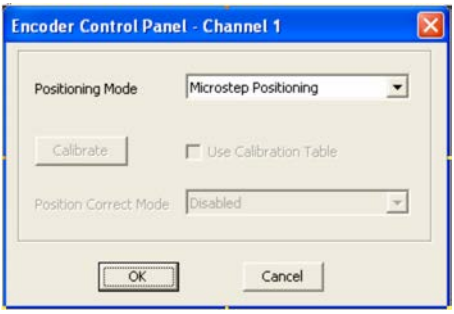


Fig. 7.2 Motor GUI panel with encoder button

2) Click the 'Encoder' button to display the 'Encoder Control Panel'.



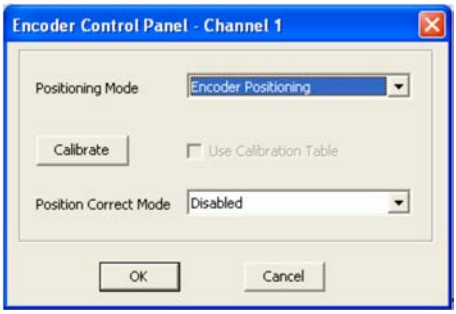
This panel is used to enable/disable encoder position feedback control and to alter the modes of operation when encoder control is enabled.

Positioning Mode

MicroStep Positioning - By default the software is set to 'Microstep Positioning' mode. In this mode, all position displays and motor moves are based on positions derived from the internal microstep counters within the controller (i.e. are not based on the encoder count).

For example, the APT system can control to a resolution of 409600 microsteps per revolution. For a stage or actuator with a 1 mm pitch lead screw, the controller will generate 409600 microsteps to move 1 mm. To display position values, the software converts the microstep count into a 'real world' position by dividing by 409600.

Encoder Positioning - If 'Encoder Positioning' is selected, other controls on the panel become available.



In this mode, the position displays on the GUI panel, and all motor moves, are based on positions derived from the encoder system fitted to the stage/actuator. So for example, the encoders currently fitted to our stages are set to 10000 counts per mm (i.e. 0.1micron per count). To move 1 mm, the controller will drive out the appropriate number of microsteps to result in an encoder count change of 10000. To display position values, the software will convert the encoder count into a 'real world' position by dividing by 10000.

Note

The position values returned by the GetPosition and GetPositionEx methods are derived from the microstep count in 'Microstep Positioning' mode and from the encoder count in 'Encoder Positioning' mode - see the APTServer helpfile for more details

7.2.2 Encoder Calibration Table

For a perfect 1mm pitch lead screw, a microstep count of 409600 would equate exactly to an encoder count of 10000. However, due to lead screw pitch, non-linearity and other cyclic errors, this is not achievable in the ‘real world’. It is the purpose of the encoder feedback handling within the APT software to accommodate for this and achieve the required encoder position (the more accurate position reading).

One way to accommodate for this lead screw non-linearity is for the system to acquire a look up table of microstep count verses encoder count readings. Using this 'calibration' table the system is then able to adjust the microstep count required (to drive the motor) to achieve the required encoder count.

Setting Up a Calibration Table

There are various user settings which relate to encoder calibration table acquisition.

1) Click the 'Settings' button on the motor GUI, and select the 'Encoder' tab.

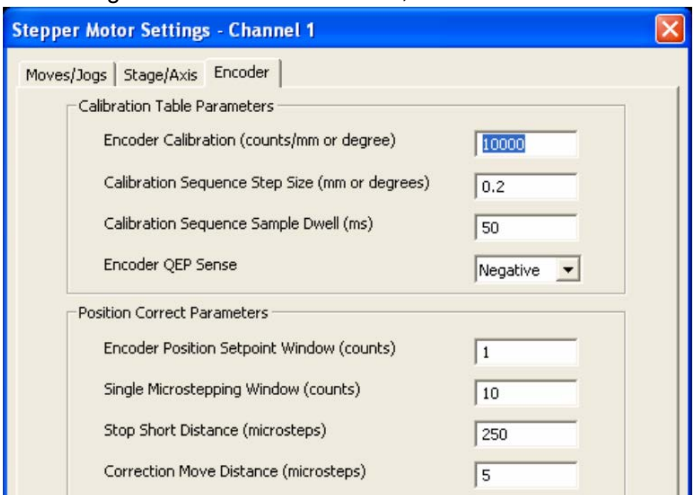


Fig. 7.3 Motor settings - Encoder tab

2) The upper collection of settings on this panel relate to Calibration Table functionality (see Section 7.2.3. for details on the lower collection of settings).

   Encoder Calibration - Sets the overall encoder calibration factor in counts/mm or counts/degree. On encoder equipped stages currently available, this factor is factory set to 10000 (i.e. 10000 counts/mm or 0.1micron per count).

   Calibration Sequence Step Size (mm or degrees) - Specifies the stepping distance to use when a calibration table is acquired. For example, a stepping distance of 0.2mm instructs the system to stop every 0.2mm, to read the encoder count during a calibration sequence.

   Calibration Sequence Sample Dwell (ms) - In many cases it is good practise to allow the stage mechanics to settle for a short period (allowing vibrations and other transients to die down) before sampling the encoder reading.

   This parameter specifies the dwell time (in ms) to wait at each position point visited during an encoder calibration sequence, before reading the encoder count.

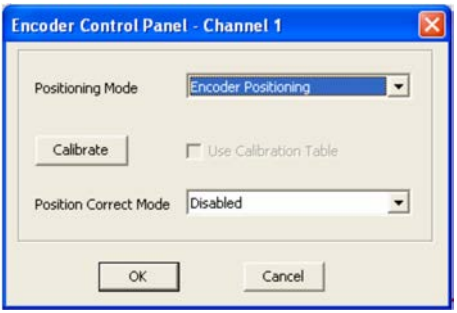
   Encoder QEP Sense - Specifies the sense of the encoder signals being read by the controller electronics, i.e. positive or negative. There is one setting applicable for a particular stage/encoder system and when set should not be altered.

Note

These settings are set to suitable defaults automatically when an encoded stage type has been associated with the motor channel (using the APT Config utility).

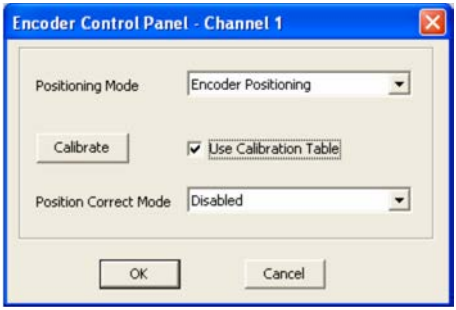
Acquiring a Calibration Table

1) Click the 'Calibrate' button on the Encoder control panel (or call the CalibrateEnc method).



The 'Encoder Control Panel' closes and the system begins the calibration sequence by first homing the channel and then moving through a series of user defined microstep position points taking the encoder reading at each. This process can take several minutes.

Once a calibration table has been acquired it can be enabled by clicking the 'Use Calibration Table' checkbox.



Note

The ‘Use Calibration Table’ checkbox is not enabled automatically and must be enabled in the 'Encoder Control Panel'.

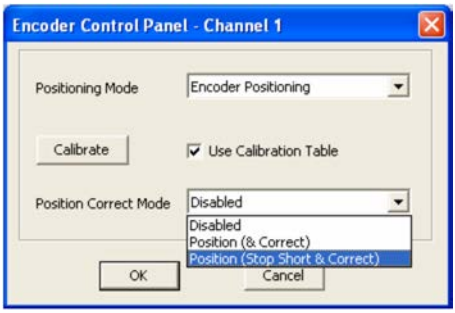
It is not compulsory to use the calibration data (i.e. checking the 'Use Calibration Tabel’ checkbox), however this is advisable if best system performance when using encoder equipped stages is to be obtained.

The encoder calibration table is used to generate the calibrated positions values returned by the GetPositionEx method when in 'Encoder Positioning' mode.

When in encoder positioning mode, the encoder calibration table overrides any other calibration table associated with the particular motor channel using the APT Config utility.

7.2.3 Position Correction Mode

In addition to the calibration table, the APT software can be set to invoke further positioning correction at the end of an encoded move. This can sometimes be required when there has been thermal drift in the mechanics since the time the calibration table was acquired. There are two position correction modes available, 'Position (& Correct)' and 'Position (Stop Short & Correct)' selected using the 'Position Correct Mode' drop down list.



Note

For best performance, the backlash correction distance should be set to zero (either by calling the SetBLashDist method, or via the Settings panel Move/Jogs tab.

Position (& Correct)

In 'Position (& Correct)' mode, the system first attempts to move to the required encoder based position (with or without calibration table support), and then adjusts the motor position, using a series of very small correction steps, until the required encoder position is achieved.

The various correction stepping parameters that affect this operation are found on the 'Encoder' tab of the settings tabbed dialog accessed using the 'Settings' button on the main graphical panel.

Note that depending on the nature of the lead screw, the stage/actuator may end up either side of the required position. The correction moves will be applied in both forward or reverse directions as required in order to achieve the required encoder position.

In some applications it is desirable to always 'reach' the required final position from the same direction (conventionally using positive moves on Our stages). To support this, the second 'Position (Stop Short & Correct)' correction mode is available.

Position (Stop Short & Correct)

When this mode is selected the system stops short of the intended position by a user specified distance and then issues small position correction steps to achieve the

required final encoder position. Again the user adjustable parameters associated with this operation are found on the 'Encoder' tab of the settings tabbed dialog, accessed using the 'Settings' button on the main graphical panel.

There are various user settings which relate to the position correction modes discussed above.

1) Click the 'Settings' button on the motor GUI, and select the 'Encoder' tab.
   The lower collection of settings on this panel relate to encoder position functionality (see Section 7.2.2. for details on the upper collection of settings)..

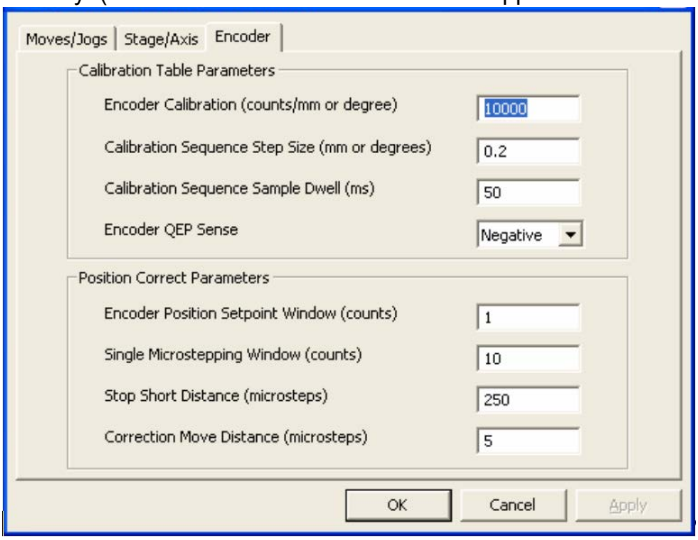


Fig. 7.4 Motor settings - Encoder tab

There are two encoder positioning correction modes as described previously. The following parameters are used to adjust the operation of these correction modes.

Consider the following diagram that illustrates the role of each parameter:

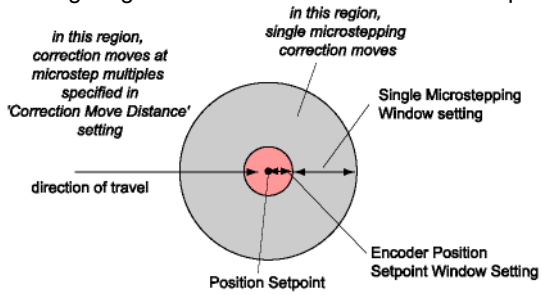


Fig. 7.5 Positioning correction mode parameters

Encoder Position Setpoint Window (counts) - When an encoded move is corrected, the system attempts to 'reach' a required position setpoint (i.e. encoder count). This parameter specifies a window of acceptability (in encoder counts) that the system must achieve.

For example, when set to a value of 1, the system must get to within 1 encoder count either side of the required position. This setting is useful for noisy systems (i.e. mechanical noise causing jitter on the encoder count) where achieving a precise encoder count may prove difficult.

For an encoder calibration factor of 10000/mm, a value of 1 for this setting means the system will position to within +-0.1micron of the required position.

Single Microstepping Window - Specifies a window within which the system attempts to reach the required position setpoint by single microstep stepping - a very accurate stepping mode. For example, if this parameter is set to a value of 10, and if the encoded move initially ends up within 10 counts (1 micron for a calibration factor of 10000) either side of the required position, the system will single microstep to reach the required position.

If at the end of the initial encoded move, the system detects the encoder position is outside of this window, then the system steps at whatever multiple of microsteps is specified by the 'Correction Move Distance' parameter described below, until the encoder position falls within the Single Microstepping Window and single microstepping can take place.

Stop Short Distance - When the 'Position (Stop Short & Correct)' position correction mode is enabled (described in the Encoder Operation section), this parameter specifies the distance (in microsteps) to stop short of an encoded move.

Assuming 409600 microsteps per revolution of the stepper motor and a 1mm pitch lead screw, a value of 4100 equates to approximately 10 microns stop short distance.

Correction Move Distance - Specifies the size of correction step (in microsteps) to use when the system issues correction moves outside of the distance set in the 'Single Microstepping Window' parameter described above.

Assuming 409600 microsteps per revolution of the stepper motor and a 1mm pitch lead screw, a value of 80 equates to approximately 0.2 micron step size.

Note

These settings are set to suitable defaults automatically when an encoded stage type has been associated with the motor channel (using the APT Config utility).

Chapter 8 Regulatory

8.1 Declarations Of Conformity

8.1.1 For Customers in Europe

E C Declaration of Conformity

We,

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

declare that the motorized travelling stages of the LNR50E 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 11 (day) day of July (month) 2012 (year)

Name: **Keith Dhese**

Position: **General Manager**

8.1.2 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.

Chapter 9 Thorlabs Worldwide Contacts

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

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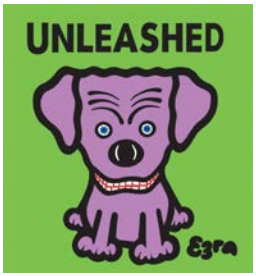
China
Thorlabs China
chinasales@thorlabs.com

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



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