BSC201
Benchtop Stepper Motor Controller

User Guide



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Chapter 1 Safety

1.1 Safety Information

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

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

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.

Caution

If your PC becomes unresponsive (e.g due to an operating system problem, entering a sleep state condition, or screen saver operation) for a prolonged period, this will interrupt communication between the Software and the hardware, and a communications error may be generated. To minimize the possibility of this happening it is strongly recommended that any such modes that result in prolonged unresponsiveness be disabled before the software is run. Please consult your system administrator or contact Thorlabs technical support for more details.

Chapter 2 Overview

2.1 Introduction

The BSC201 is an enhanced single-channel Stepper Motor Controller using the Kinesis software. Many features are provided, including a choice between trapezoidal and S-shaped velocity profiles, a higher theoretical microstep resolution (409600 for a 200 full step motor) and speeds more than twice that achieved by their predecessors.

It is designed to drive larger framed 2-phase bipolar stepper motors, with and without encoder feedback, and can be used in a wide variety of applications. These high power units deliver up to 48V/50W peak (25W average) drive power per channel and are compatible with most stepper driven nano-positioning actuators & stages in the Thorlabs range.

The unit combines the latest high speed digital signal processors (DSP) with low-noise analog electronics and the latest software technology for effortless high resolution microstepping of up to three axes. Additional axes can be driven by connecting one or more benchtop units via a standard USB hub.The stepper motor controller is supplied with a full suite of software support tools. An intuitive graphical instrument panel allows immediate control and visualization of the operation of the stepper controllers, and any other controllers that are installed in the system. See Chapter 5 for a full description of the software.



Fig. 2.1 Single Channel Stepper Motor Controller (BSC201)

Stepper motors give excellent low speed performance and positioning stability compared with DC servo motors. A wide range of 2-phase bipolar stepper motors and associated actuators are commercially available, each with its own characteristics, such as step resolution, peak phase current or voltage, and lead screw pitch. For this reason the stepper unit operation is fully configurable (parameterized) with key settings exposed through the associated graphical interface panels.

Motor step resolution, and lead screw pitch can be set for a particular motor/actuator combination, phase currents can be limited to suitable peak powers as required, and limit switch configuration is accommodated through a flexible set of limit switch logic settings. Moreover, relative and absolute moves can be initiated with move profiles set using velocity profile parameters. Similarly, home sequences have a full set of associated parameters that can be adjusted for a particular stage or actuator. For simplicity of operation, the software incorporates pre-configured settings for each of the Thorlabs stages and actuators, while still exposing all parameters individually for use with other stepper motor driven systems.

For convenience and ease of use, adjustment of many key parameters is possible through direct interaction with the graphical panel. For example a move to the next position can be initiated by clicking directly on the position display and entering a new value (see the tutorial in Chapter 4 for further details). Furthermore, all such settings and parameters are also accessible through the programmable interfaces for automated alignment sequences.

The stepper unit also supports encoder feedback through dedicated quadrature encoded pulse (QEP) inputs, one for each channel of operation. Through conversion routines, the software is able to use this feedback signal to generate encoder position for access either through the GUI or via programmable interfaces for custom closed loop algorithms. A “built in” algorithm can be enabled to allow the stepper system to reach and maintain an encoded position through an iterative move sequence. Please see the Kinesis software API online helpfile or the handbook supplied with your linear encoded stage for further details.

2.2 Kinesis Software Overview

2.2.1 Introduction

The BSC201 controllers share many of the benefits of the Thorlabs range of motor controllers. These include USB connectivity (allowing multiple units to be used together on a single PC), fully featured Graphical User Interface (GUI) panels, and extensive software function libraries for custom application development.

The Kinesis software suite provides a flexible and powerful PC based control system both for users of the equipment, and software programmers aiming to automate its operation.

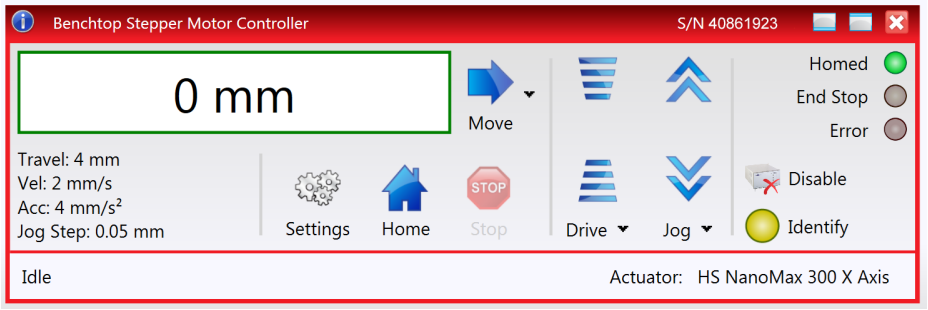
The User Interface allows full control of all settings and operating modes enabling complete 'out-of-box' operation without the need to develop any further custom software. It provides all of the necessary system software services such as generation of GUI panels, communications handling for multiple USB units, and logging of all system activity to assist in hardware trouble shooting. The Kinesis server is also used by software developers to allow the creation of advanced automated positioning applications very rapidly and with great ease.

2.2.2 Kinesis Server

Kinesis controls are re-usable compiled software components that supply both a graphical user interface and a programmable interface. Many such Controls are available for Windows applications development, providing a large range of re-usable functionality. For example, there are Controls available that can be used to manipulate image files, connect to the internet or simply provide user interface components such as buttons and list boxes.

With the Kinesis system, .Net Controls are deployed to allow direct control over (and also reflect the status of) the range of electronic controller units, including the BSC201 series controllers. Software applications that use .Net Controls are often referred to as 'client applications'. A .Net Control is a language independent software component. Consequently the controls can be incorporated into a wide range of software development environments for use by client application developers. Development environments supported include Visual Basic, Labview, Visual C++, C++ Builder, HPVEE, Matlab, VB.NET, C#.NET and, via VBA, Microsoft Office applications such as Excel and Word.

Consider the control supplied for the BSC201 controller.



This Control provides a complete user graphical instrument panel to allow the stage to be manually operated, as well as a complete set of software functions (often called methods) to allow all parameters to be set and motor operations to be automated by a client application. The instrument panel reflects the current operating state of the controller unit to which it is associated (e.g. such as motor position). Updates to the panel take place automatically when a user (client) application is making software calls into the same Control. For example, if a client application instructs the associated stage to move, the progress of that move is reflected automatically by changing position readouts on the graphical interface, without the need for further programming intervention.

The Kinesis Controls collection provides a rich set of graphical user panels and programmable interfaces allowing users and client application developers to interact seamlessly with the Kinesis hardware. Each of the Kinesis controllers has an associated .Net Control and these are described fully in the handbooks associated with the controllers.

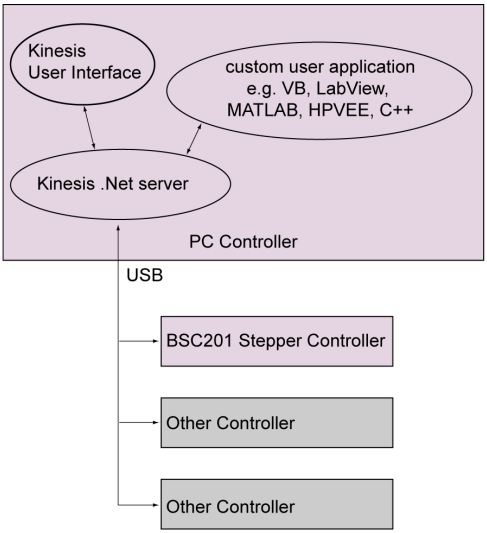


Fig. 2.2 System Architecture Diagram

Refer to the main Kinesis Software online help file, for a complete programmers guide and reference material on using the Kinesis Controls collection. This is available either by pressing the F1 key when running the Kinesis server, or via the Start menu, Start\Programs\Thorlabs\Kinesis\Kinesis Help.

2.2.3 Software Upgrades

Thorlabs operate a policy of continuous product development and may issue software upgrades as necessary.

Chapter 3 Getting Started

3.1 Installing The Software

Note

When operating via a PC, direct user interaction with the unit is accomplished through intuitive graphical user interface panels (GUIs), which expose all key operating parameters and modes. The user can select multiple panel views displaying different information about a particular hardware unit. The multitasking architecture ensures that the graphical control panels always remain live, showing all current hardware activity.

Caution

Some PCs may have been configured to restrict the users ability to load software, and on these systems the software may not install/run. If you are in any doubt about your rights to install/run software, please consult your system administrator before attempting to install.

If you experience any problems when installing software, contact Thorlabs on +44 (0)1353 654440 and ask for Technical Support.

DO NOT CONNECT THE CONTROLLER TO YOUR PC YET

1) Download the software from www.thorlabs.com.
2) Locate the downloaded setup.exe file and move to a suitable file location.
3) Double-click the setup.exe file and follow the on-screen instructions.

3.2 Mechanical Installation

3.2.1 Siting

The BSC201 is designed to be mounted free standing on a shelf, benchtop or similar surface.

Caution

When siting the unit, it should be positioned so as not to impede the operation of the rear panel power supply switch or the control panel buttons.
Ensure that proper airflow is maintained to the rear of the unit.

3.2.2 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 Electrical Installation

Warning

The safety of any system incorporating this equipment is the responsibility of the person performing the installation.

3.3.1 Connecting To The Supply

Shock Warning

The unit must be connected only to an earthed fused supply of 110 to 230V.

Use only power supply cables supplied by Thorlabs, other cables may not be rated to the same current.

The unit is shipped to the UK, Europe and the USA, with the appropriate power plug already fitted. When shipped to other territories the appropriate power plug must be fitted by the user. Cable identification is as follows:

Brown-Live
Blue-Neutral
Green/Yellow-Earth/Ground

3.3.2 Fuses

Two T 3 A/250 V a.c. antisurge ceramic fuses are located on the back panel, one for the live feed and one for the neutral as follows:

Fuse	Rating	Type	Fused Line
F1	T 3.15 A	ceramic; antisurge	Live feed
F2	T 3.15 A	ceramic; antisurge	Neutral feed

When replacing fuses:

1) Switch off the power and disconnect the power cord before removing the fuse cover.
2) Always replace broken fuses with a fuse of the same rating and type.

3.3.3 Current Leakage.

Caution

The power supply filters may exhibit some ground loop current leakage and could trip very sensitive detection circuits.

3.3.4 Rear Panel Connections

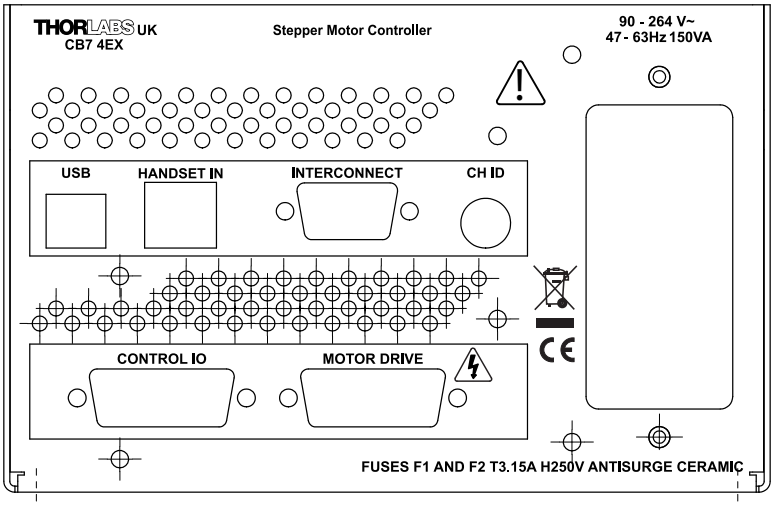


Fig. 3.1 Rear panel connections

USB - USB port for system communications.

Note

The USB cable length should be no more than 3 metres unless a powered USB hub is being used.

HANDSET IN - Provides connection for the MJC001 Joystick - see Section 4.8. and Section 6.2.

INTERCONNECT - (9-Pin D-Type, Male) For Future Use.

CH ID - For channel selection when using the MJC001 joystick - see Section 4.8.

MOTOR DRIVE - (15-Pin D-Type, Female) Provides connection to the actuator.

This connector provides all phase current drive and encoder feedback connections to drive a range of encoded and non-encoded stepper motors - see Section 6.3.

CONTROL I/O - (15-Pin D-Type, Female) The 'CONTROL I/O' connector exposes a number of electrical signals useful for external control. It is possible to configure a particular controller to respond to trigger inputs (see Section 6.1.4.), generate trigger outputs (see Section 6.1.3.) or both respond to and generate a trigger output - see Section 5.3.5. Motor jogging lines can be used to jog the motor in both forward and reverse directions from a remote handset (Jogging parameters (e.g. jog distance) are set via the GUI panel - see Section 5.3.2.)

3.4 Front Panel Controls and Indicators

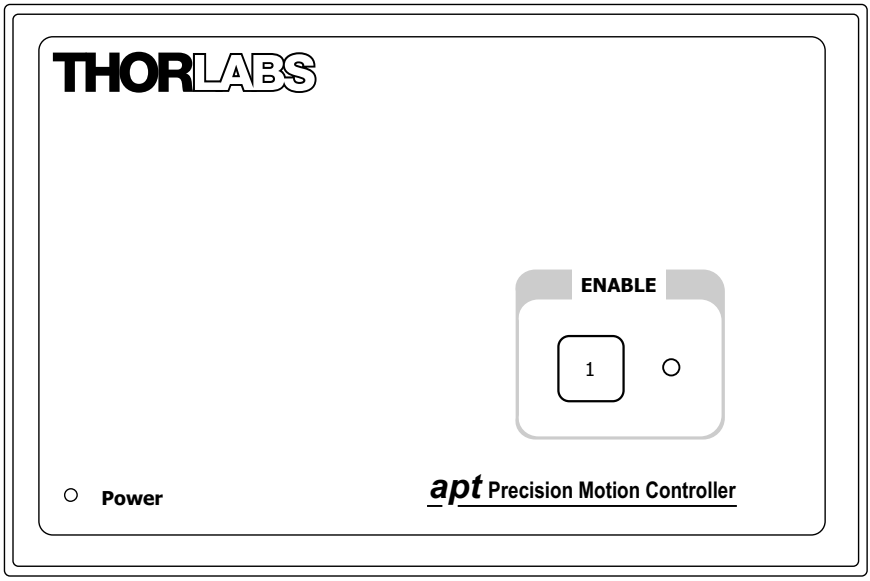


Fig. 3.2 Front panel controls and indicators

Power LED – Indicates that power is applied to the unit.

Enable button – Used to enable/disable channel functionality. The associated LED is lit when the channel is enabled. Disabling the channel allows the motor actuator to be operated manually.

3.5 Connecting The Hardware

1) Perform the mechanical installation as detailed in Section 3.2.
2) Install the Software - see Section 3.1.
3) Connect the stepper motor actuator to the Controller unit - see Section 3.3.4.
4) Connect the Controller unit to the power supply - see Section 3.3.1.
5) Connect the PSU to the main supply and switch 'ON'.
6) 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).

7) Windows® should detect the new hardware. Wait while Windows® installs the drivers for the new hardware - see the Getting Started guide for more information.

3.6 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, a stage association can be made which enables the Kinesis server to apply automatically, suitable default parameter values on boot up of the software. With some Thorlabs stages, the controller will recognise the stage at switch on, and no further action is required; for others, it is necessary to tell the controller which stage is connected as follows.

Caution

Make sure to make the correct stage association. Incorrect selection of the connected stage or actuator could result in damage to the motor. If using the virtual comms port (see Chapter 7), this is done using the MGMSG_MOT_SET_TSTACTUATORTYPE command.

Note

Even if a stage type and axis has been associated with the controller, it is still possible to alter these parameters if required, (e.g. for a custom stage type not selectable using the Kinesis software) - see Section 5.3.4.

Note

To use the increased resolution and velocity funcitionality offered by these controllers, the stage types prefixed by 'HS' (e.g. HS NanoMax 300 X Axis) must be selected. Failure to select the correct stage type will result in reduced velocity and resolution.

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) The 'Actuator/Startup Settings ' window is displayed.

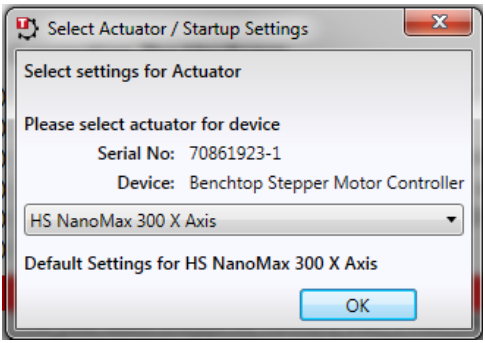


Fig. 3.3 Stage Configuration Window

4) Select your actuator type (e.g. HS NanoMax 300 X-Axis) from the list displayed.

Note

To use the increased resolution and velocity funcitionality offered by these controllers, the stage types prefixed by 'HS' (e.g. HS NanoMax 300) must be selected. Selecting a stage/actuator type without the 'HS' prefix will result in reduced velocity and resolution.

5) Click OK.
6) The server reads in the stage and controller information automatically. Proceed to Section 3.7. to verify the software operation.

3.7 Verifying Software Operation

3.7.1 Initial Setup

The Software should be installed (Section 3.1.) and the stage association performed (Section 3.6.) before software operation can be verified.

1) Run the Kinesis software and check that the Graphical User Interface (GUI) panel appears and is active.

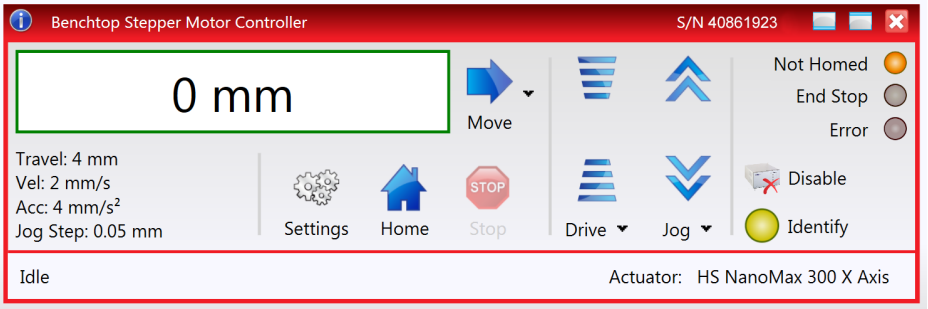


Fig. 3.4 Gui panel showing jog and ident buttons

2) Click the 'Identify' button. The associated channel LED on the front panel of the controller flashes. This is useful in multi-channel systems for identifying which channel is associated with which GUI.
3) Click the jog buttons on the GUI panel and check that the motor or axis connected to the controller moves. The position display for the associated GUI should increment and decrement accordingly.

Follow the tutorial steps described in Chapter 4 for further verification of operation.

Chapter 4 Operation - Tutorial

The following brief tutorial guides the user through a typical series of moves and parameter adjustments performed using the Kinesis software. It assumes that the unit is electrically connected as described in Section 3.3. and that the software is already installed - see Section 3.1.

4.1 Using the Kinesis Software

The Kinesis software application allows the user to interact with any number of hardware control units connected to the PC USB Bus. This program allows multiple graphical instrument panels to be displayed so that multiple units can be controlled. All basic operating parameters can be set through this program, and all basic operations (such as motor moves) can be initiated. Parameter settings can be saved, which simplifies system set up whenever the software is run up.

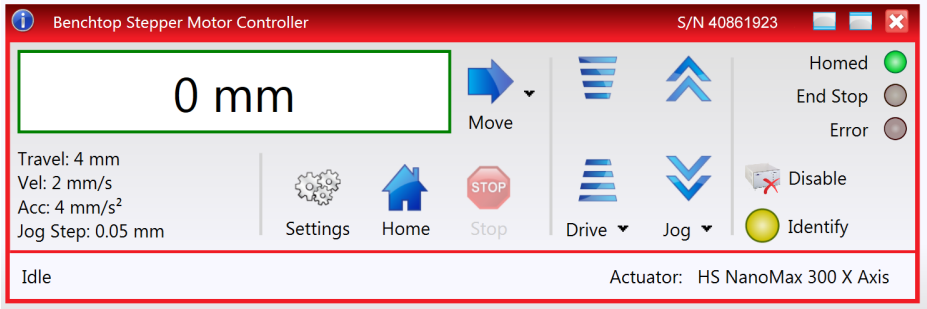


Fig. 4.1 Typical User Screen

1) Run the Kinesis software - Start/All Programs/Thorlabs/Kinesis/Kinesis.

Notice how the HS NanoMax 300 X Axis actuator type, selected in Section 3.6. is displayed in the 'Settings' window. See Section 5.3. for further details on the parameter values shown in the 'Settings' display.

4.2 Homing Motors

Homing the motor moves the actuator to the home limit switch and resets the internal position counter to zero. The limit switch provides a fixed datum that can be found after the system has been powered up.

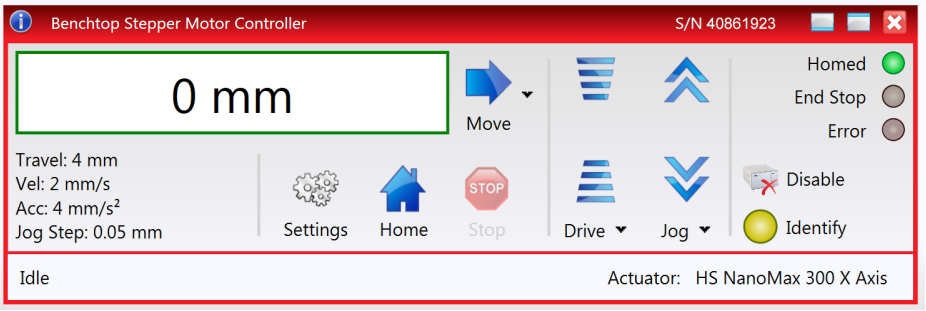


Fig. 4.2 Motor Controller Software GUI

1) Click the 'Home' button. Notice that the 'Not Homed' LED changes to 'Homed', and that the LED flashes to indicate that homing is in progress. The displayed position counts down to 0, i.e the home position.

Note

Homing can also be performed at the unit, by holding down both front panel buttons for around 2 seconds.

2) When homing is complete, the 'Homed' LED is lit as shown above.

See Section 10.2.2. for background information on the home position.

4.3 Changing Motor Parameters and Moving to an Absolute Position

Absolute moves are measured in real world units (e.g. millimetres), relative to the Home position.

Moves are performed using a trapezoidal or S-Curve velocity profile (see Section 10.1.3.). The velocity settings relate to the maximum velocities at which a move is performed, and the acceleration at which the motor speeds up from zero to maximum velocity.

1) On the GUI panel, click the Move arrow  to show the Settings panel.

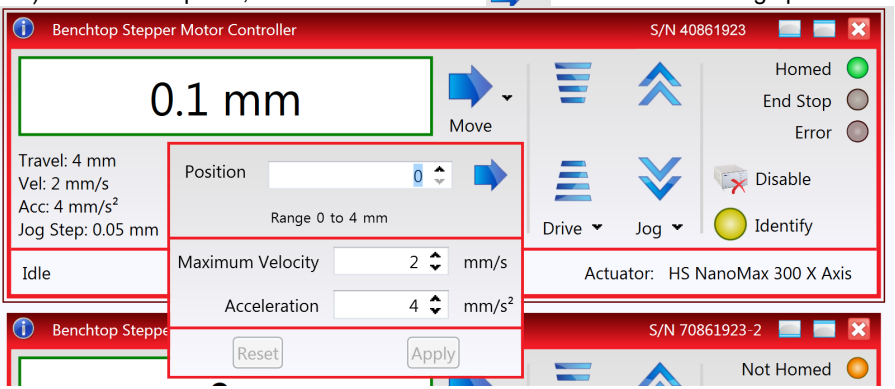


Fig. 4.3 Move Settings Panel

2) Enter the required absolute position and/or parameter values.
3) To move to the position entered click the arrow .
4) Click ‘Apply’ to save the parameter settings and close the window, click Reset to return to the previously saved values.

4.4 Stopping the Stage

The drive channel is enabled and disabled by clicking the ‘Enable’ button on the GUI panel or the top panel of the unit. The green indicator is lit when the drive channel is enabled. Disabling the channel removes the drive power and allows the stage/ actuator to be positioned manually.

During operation, the stage can be stopped at any time by clicking the ‘Stop’ button on the GUI panel. Using this button does not remove power to the drive channel.

4.5 Jogging

During PC operation, the motor actuators are jogged using the GUI panel arrow keys. There are two jogging modes available, 'Single Step' and 'Continuous'. In 'Single Step' mode, the motor moves by the step size specified in the Step Distance parameter. If the jog key is held down, single step jogging is repeated until the button is released - see Fig. 5.3. In 'Continuous' mode, the motor actuator will accelerate and move at the jog velocity while the button is held down.

1) On the GUI panel, click the word 'Jog' Jog to display the Settings panel.

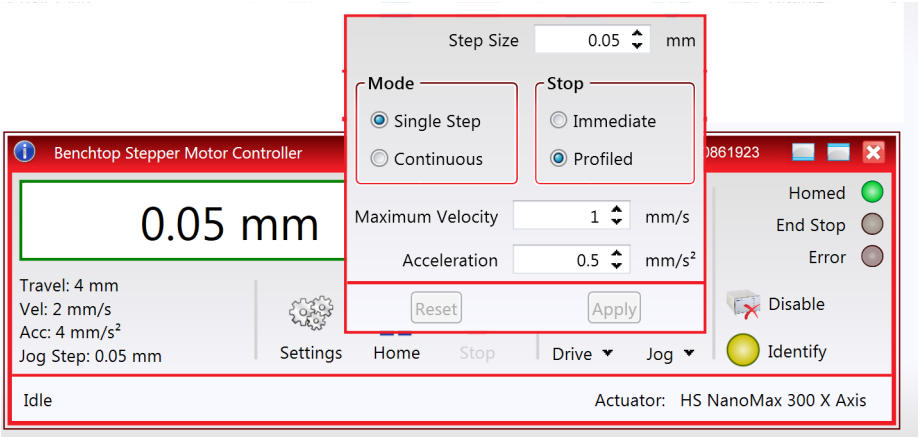


Fig. 4.4 Jog Settings Panel

2) Make parameter changes as required.

Note

In current versions of software, the 'Min Vel' parameter is locked at zero and cannot be adjusted.

3) Click 'Apply' to save the settings and close the window, click Reset to return to the previously saved values.

4.6 Setting Move Sequences

The Kinesis software allows move sequences to be programmed, allowing several positions to be visited without user intervention. For more details and instructions on setting move sequences, please see the *Kinesis Helpfile*.

4.7 Changing and Saving Parameter Settings

During operation, certain settings (e.g. max velocity, jog step size etc) can be changed as required. Other settings (e.g. PID parameter values) cannot be changed so easily. When the Kinesis Server is run up and the stage/acuator association made, suitable default settings are loaded and these values have been chosen to provide safe performance in the majority of applications. However, for applications where these settings need to be changed, a new set of Device Start Up settings', must be created which can then be applied and/or uploaded on subsequent start up. See the *Kinesis Helpfile* for more details.

4.8 Using A Joystick Console

The MJC001 joystick console has been designed to provide intuitive, tactile, manual positioning of the stage. The console features a two axis joystick for XY control. Up to 3 joysticks can be connected to each other, interfacing neatly into a multi-channel control application.

Note

The default parameter values loaded at the factory should be acceptable for most applications, and in this case, it is not necessary to connect the controller to a PC running the software. If these parameter values subsequently require adjustment, this can only be performed by running the software - see Section 5.3.6. for more information.

Note

In order for the controller and joystick to be used without a host PC, the Move/ Jog settings, Stage/Axis settings and the Joystick settings must be persisted (saved) within the BSC201 unit before the following predure is performed. This is done by checking the 'Persist Settings' box on each settings tab - see Section 5.3. for more details.

1) Connect the stage to the Controller unit.
2) Connect the joystick console to the HANDSET IN connector of the controller.
3) Switch ON the controller.
4) Wait until the red led on the joystick console and the Channel Enable LED on the controller front panel stops flashing (~3s).
   Press and hold the 'High/Low' button for 2 seconds to home the stage. When homing is complete, the green LED stops flashing.

In order to establish control over a particular axis, the joystick axes must be associated with the corresponding channels of the related controller. This is achieved by setting the joystick ID switch, located on the underside of the joystick console, and the channel ident switches on the rear panel of the BSC controller.

The joystick ID switch assigns the selected number to the X axis of the joystick and the next sequential number to the Y axis. The channel ident switches on the controller unit(s) must then be set to match these joystick axis numbers.

For example, if the joystick switch is set to '1', then the channel ID switch on the controller must also be set to '1' as shown in Fig. 4.1. If two single channels are being used, the Y-Axis controller unit must be set to '2'.



Fig. 4.1 ID switch setings

5) Set the joystick console ID switch and the controller channel ID switches as described in the preceding paragraph.

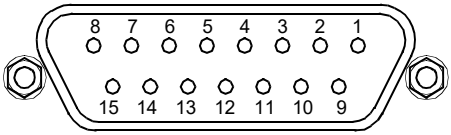
Caution

Do not set the switches to identical numbers as this may result in lack of joystick control. Also, do not set the channel ID switches to 'E' or 'F' as this is reserved for factory use and testing.

6) Open the software and ensure that the appropriate ‘HS’ option is selected for the actuator being driven (e.g. HS 17DRV013). If an option without the HS prefix is seleceted, then the joystick will not function - see Section 3.6.
7) The stage can now be moved using the joystick, GUI panel, or by setting commands to move each axis by relative and absolute amounts – see the helpfile supplied with the Kinesis server for more information.

4.9 External Triggering

External triggering is facilitated by the Trigger In and Trigger Out pins (pins 4 and 12) of the CONTROL IO connector on the rear panel of the unit.



These connectors provide a 5V logic level input and output that can be configured to support triggering from and to external devices - see Section 5.3.5. and Section 6.1.3. for further details.

Chapter 5 Software Reference

5.1 Introduction

This chapter gives an explanation of the parameters and settings accessed from the software running on a PC.

5.2 GUI Panel

The following screen shot shows the graphical user interface (GUI) (one panel per channel) displayed when accessing the controller using the Kinesis software.

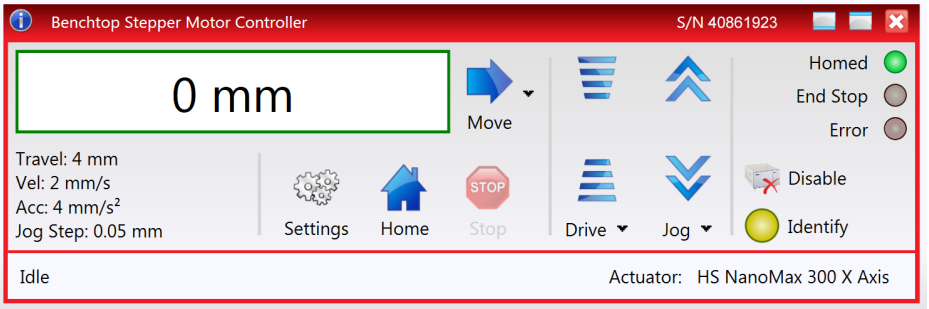


Fig. 5.1 BSC201 Software GUI

Note

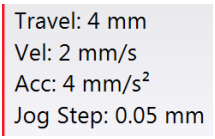
The serial number of the BSC201 controller card associated with the GUI panel is displayed in the top right hand corner. This information should always be provided when requesting customer support.



Position window - shows the position (in millimetres or degrees) of the motor. The motor must be 'Homed' before the display will show a meaningful value, (i.e. the displayed position is relative to a physical datum, the limit switch).



Move - Opens the settings window, so that position data and velocity parameters can be entered - see Section 4.3. Moves are performed using the current velocity parameters which can be changed in the same panel. The present settings are displayed below the window.



Velocity Parameters - the present setting for the move velocity parameters and the jog step size. The travel range of the associated stage/actuator is also displayed.

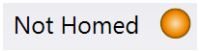
These settings can be adjusted as described previously, or by clicking the Settings button to display the settings window, see Section 5.3.2.



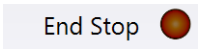
Jog Controls - used to increment or decrement the motor position. The controls comprise a bar graph and a set of jog arrows.

Each division of the bar graph represents a different velocity. The velocities are entered in the settings panel which is displayed by clicking 'Drive' or the small down arrow.

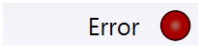
When the arrows are clicked, the motor is driven in the selected direction at the jog velocity, one step per click. The step size and jog velocity parameters can be changed by clicking 'Jog' or the small down arrow to display the settings panel.



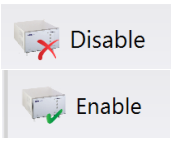
Homed/Not Homed - lit when the motor has not been 'Homed' since power up. When the home button is clicked, the caption changes to 'Homed' and the LED flashes while the home move is being performed. The LED is lit green once the move is complete.



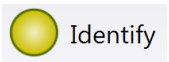
End Stop - lit when a limit switch is activated, i.e. the motor is at its end stop.



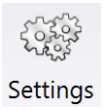
Error - lit when a fault condition occurs.



Enable/Disable - applies and removes power to the motor. With the motor enabled, only the Disable button is visible, and with the motor disabled only the Enable button is visible.



Identify - when this button is pressed, the ACTIVE LED on the front panel of the associated hardware unit will flash for a short period.



Settings - Displays the 'Settings' panel, which allows the operating parameters to be entered for the motor drive - see Section 5.3.

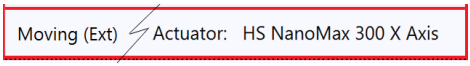


Home - sends the motor to its 'Home' position - see Section 10.2.2.

Stop - halts the movement of the motor.



Lower Display - Shows the present state of the motor, e.g. Idle, Moving, Moving EXT or Homing.



Also shows the part number of the associated actuator or stage.

5.2.1 Keyboard Shortcuts

Certain functionality can also be accessed via PC keyboard shortcuts as follows:

Jog Forwards	'Ctrl' + 'F', 'Ctrl' + '+'
Jog Backwards	'Ctrl' + 'B', 'Ctrl' + '-'
Home	'Ctrl' + 'H', 'Ctrl' + 'Home'
Stop	'Ctrl' + '0'
Jog Forward1	'LeftCtrl' + '1' (Hold to move)
Forward2	'LeftCtrl' + '2' (Hold to move)
Forward3	'LeftCtrl' + '3' (Hold to move)
Forward4	'LeftCtrl' + '4' (Hold to move)
Backward1	'RightCtrl' + '1' (Hold to move)
Backward2	'RightCtrl' + '2' (Hold to move)
Backward3	'RightCtrl' + '3' (Hold to move)
Backward4	'RightCtrl' + '4' (Hold to move)
GoTo	'Enter' (On target position box)

5.3 Settings Panel

When the 'Settings' button on the GUI panel is clicked, the 'Settings' window is displayed. This panel allows motor operation parameters such as move/jog velocities, and stage/axis information to be modified. Note that all of these parameters have programmable equivalents (refer to the *Kinesis Server helpfile* for further details.

5.3.1 Persisting Settings to Hardware

Many of the parameters that can be set for the BSC201 controllers can be stored (persisted) within the unit itself, such that when the unit is next powered up these settings are applied automatically. This is particularly important when the driver is being used manually in the absence of a PC and USB link. The Velocity Profile and Jogging parameters described previously are good examples of settings that can be altered and then persisted in the driver for use in absence of a PC. To save the settings to hardware, check the '*Persist Settings to the Device'* checkbox before clicking the 'OK button.

Caution

The 'Persist Settings' functionality is provided to simplify use of the unit in the absence of a PC. When the unit is connected to a PC and is operated via KinesisUser, the default KinesisServer settings will be loaded at boot up, even if the 'Persist Settings' option has been checked.

5.3.2 Moves/Jogs Tab

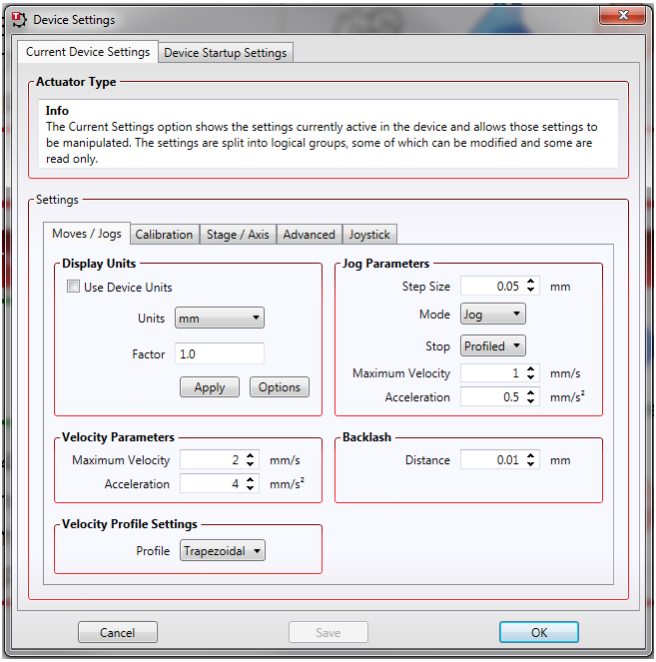


Fig. 5.2 BSC201 Series Controller - Move/Jog Settings

Display Units

By default, the unit will display position in real world units (mm or degrees). If required, the units can be changed to so that the display shows other positional units (cm, µm, µrad etc).

Units - the positioning units used on the GUI display.

Factor - the scaling factor associated with the selected units.

Jog Parameters

Jogs are initiated by using the 'Jog' keys on the GUI panel (see Section 4.5.).

Step Size - The distance to move when a jog command is initiated. The step size is specified in real world units (mm or degrees dependent upon the stage).

Mode - The way in which the motor moves when a jog command is received (i.e. front panel button pressed or GUI panel button clicked).

There are two jogging modes available, 'Jog' and 'Continuous'. In 'Jog' mode, the motor moves by the distance specified in the Step Size parameter. If the jog key is held down, single step jogging is repeated until the button is released - see Fig. 5.3.

In ‘Continuous’ mode, the motor actuator will accelerate and move at the jog velocity while the button is held down..

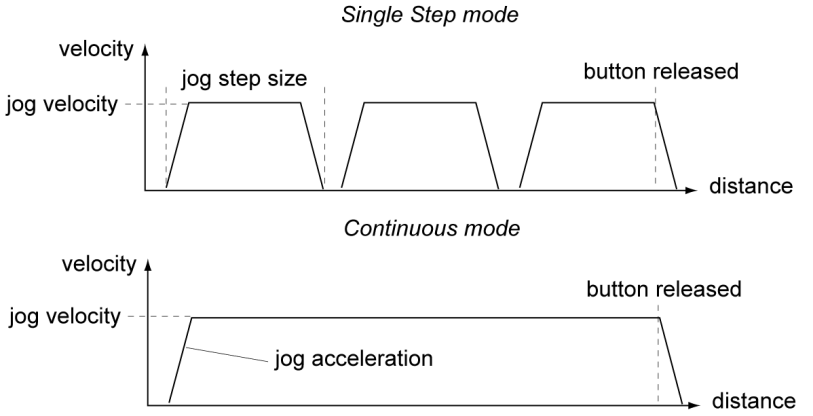


Fig. 5.3 Jog Modes

Jog - the motor moves by the distance specified in the Step Size parameter.

Continuous - the motor continues to move until the jog signal is removed (i.e. jog button is released).

Stop - the way in which the jog motion stops when the demand is removed.

Immediate - the motor stops quickly, in a non-profiled manner

Profiled - the motor stops in a profiled manner using the jog Velocity Profile parameters set above.

Maximum Velocity - the maximum velocity at which to perform a move.

Acceleration - the rate at which the velocity climbs from zero to maximum, and slows from maximum to zero.

Velocity Parameters

Moves can be initiated via the GUI panel by entering a position value after clicking on the position display box (see Section 4.3.), or by calling a software function (see the KinesisServer helpfile). The following settings determine the velocity profile of such moves, and are specified in real world units, millimetres or degrees.

Maximum Velocity - the maximum velocity at which to perform a move.

Acceleration - the rate at which the velocity climbs from zero to maximum, and slows from maximum to zero.

Note

Under certain velocity parameter and move distance conditions, the maximum velocity may never be reached (i.e. the move comprises an acceleration and deceleration phase only).

Backlash

Distance - The system compensates for lead screw backlash during reverse direction moves, by moving passed the demanded position by a specified amount, and then reversing. This ensures that positions are always approached in a forward direction. The Backlash Distance is specified in real world units (millimeters or degrees). To remove backlash correction, this value should be set to zero.

Note

Backlash correction is not implemented during a Jog move.

Velocity Profile Settings

To prevent the motor from stalling, it must be ramped up gradually to its maximum velocity. Certain limits to velocity and acceleration result from the torque and speed limits of the motor, and the inertia and friction of the parts it drives.

The system incorporates a trajectory generator, which performs calculations to determine the instantaneous position, velocity and acceleration of each axis at any given moment. During a motion profile, these values will change continuously. Once the move is complete, these parameters will then remain unchanged until the next move begins.

The specific move profile created by the system depends on several factors, such as the profile mode and profile parameters presently selected, and other conditions such as whether a motion stop has been requested.

Profile – This field is used to set the profile mode to either Trapezoidal or S-curve. In either case, the velocity and acceleration of the profile are specified using the *Velocity Profile* parameters on the *Moves/Jogs tab.*

The *Trapezoidal* profile is a standard, symmetrical acceleration/deceleration motion curve, in which the start velocity is always zero.

In a typical trapezoidal velocity profile, (see Fig. 5.4.), the stage is ramped at acceleration '*a*' to a maximum velocity '*v*'. As the destination is approached, the stage is decelerated at '*a*' so that the final position is approached slowly in a controlled manner.

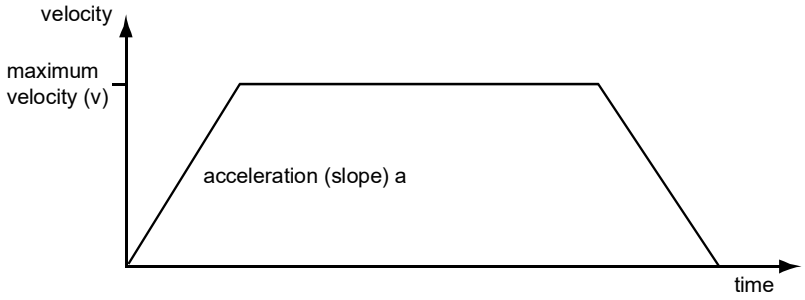


Fig. 5.4 Graph of a trapezoidal velocity profile

The *S-curve* profile is a trapezoidal curve with an additional '*Bow Value*' parameter, which limits the rate of change of acceleration and smooths out the contours of the motion profile. The *Bow Value* is applied in mm/s^3 and is derived from the *Bow Index* field as follows:

Bow Value = 2 $^{(\text{Bow Index } -1)}$ within the range 1 to 262144 (Bow Index 1 to 18).

In this profile mode, the acceleration increases gradually from 0 to the specified acceleration value, then decreases at the same rate until it reaches 0 again at the specified velocity. The same sequence in reverse brings the axis to a stop at the programmed destination position.

Example

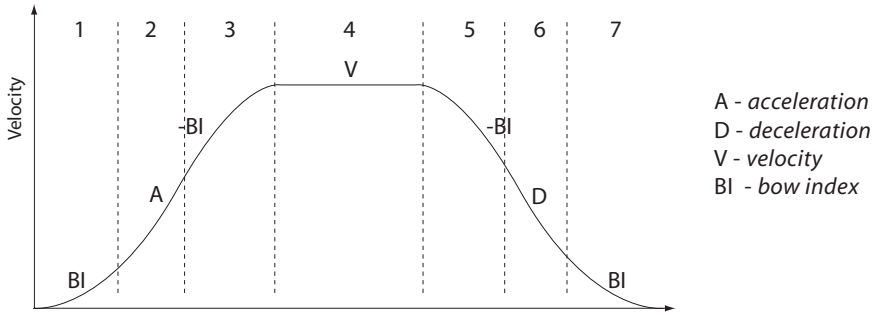


Fig. 5.5 Typical S-Curve Profile

The figure above shows a typical S-curve profile. In segment (1), the S-curve profile drives the axis at the specified Bow Index (BI) until the maximum acceleration (A) is reached. The axis continues to accelerate linearly (Bow Index = 0) through segment (2). The profile then applies the negative value of Bow Index to reduce the acceleration to 0 during segment (3). The axis is now at the maximum velocity (V), at which it continues through segment (4). The profile then decelerates in a similar manner to the acceleration phase, using the Bow Index to reach the maximum deceleration (D) and then bring the axis to a stop at the destination.

Note

The higher the Bow Index, then the shorter the BI phases of the curve, and the steeper the acceleration and deceleration phases. High values of Bow Index may cause a move to overshoot or may result in instability.

5.3.3 Calibration Tab

Note

This section is applicable only to NRT100, NRT150, LTS150, LTS300 and MLJ050 series stages, DRV013 and DRV014 actuators.

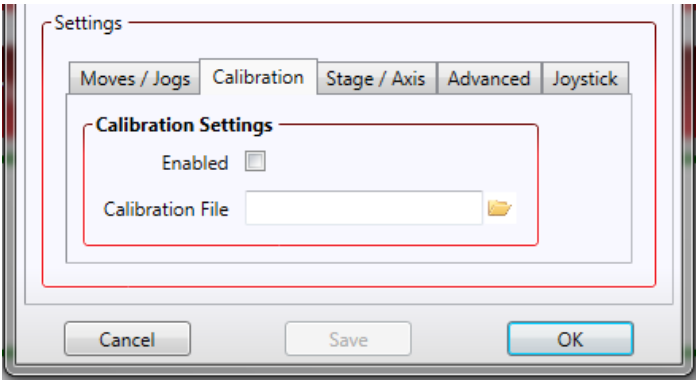


Fig. 5.6 BSC201 Series Controller - Calibration Settings

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 particular stage. Whenever the stage is moved, the LUT is consulted to ascertain the precise movement required to achieve the demanded position.

A calibration file is shipped with each unit. 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.

To assign a calibration file:

1) Click the ‘Enabled’ Checkbox.
2) Click the folder icon and navigate to the location of the required calibration file.
3) Select the file so that the file name is displayed in the ‘Calibration File’ field.
4) Click OK.

5.3.4 Stage/Axis Tab

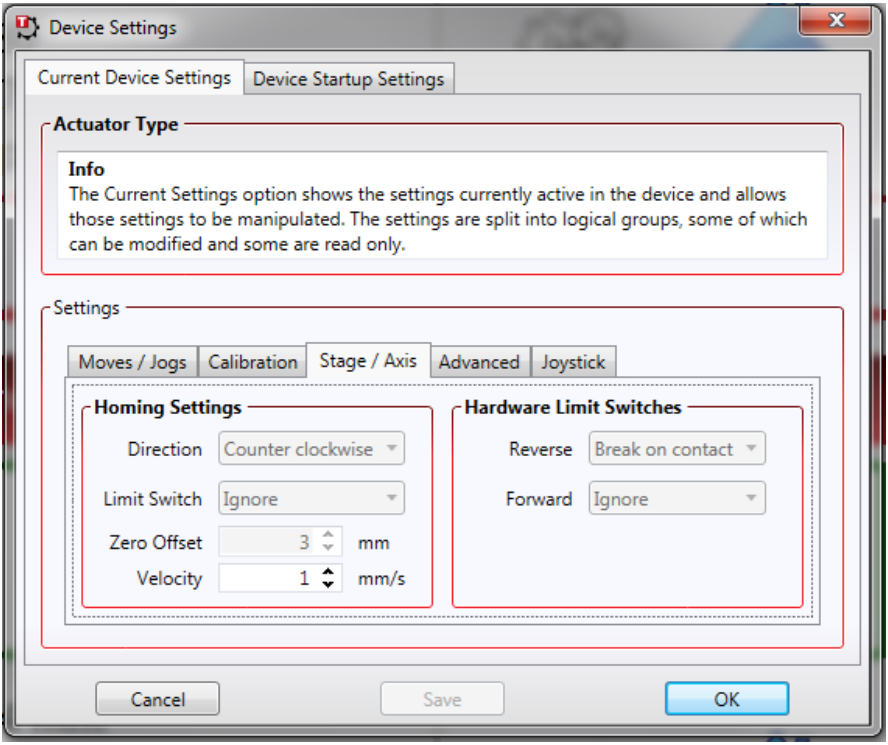


Fig. 5.7 BSC201 Series Controller - Stage/Axis Settings

Note

This tab contains a number of parameters which are related to the physical characteristics of the particular stage being driven. They need to be set accordingly such that a particular stage is driven properly by the system.

For BSC201 series controllers, the Kinesis software will automatically apply suitable defaults for the parameters on this tab during boot up of the software and these parameters should not normally be altered subsequently as it may adversely affect the performance of the stage. Descriptions are provided for information only.

For custom stage types not available using the Kinesis software, the stage details must be entered manually - see the software overview for more details.

Homing Settings

When homing, a stage typically moves in the reverse direction, (i.e. towards the reverse limit switch). The following settings allow support for stages with both Forward and Reverse limits.

Note

Typically, the following two parameters are set the same, i.e. both Forward or both Reverse.

Direction - the direction sense that the motor moves when homing, either *Clockwise* or *Counter Clockwise*.

Limit Switch - The hardware limit switch associated with the home position, either Ignore, *Clockwise or Counter Clockwise*.

Zero Offset - the distance offset (in mm or degrees) from the limit switch to the Home position.

Velocity - the maximum velocity at which the motors move when Homing.

For further information on the home position, see Section 10.2.2.

Hardware Limit Switches

Note

The minimum velocity and acceleration/deceleration parameters for a home move are taken from the existing move velocity profile parameters.

The operation of the limit switches is inherent in the design of the associated stage or actuator. The following parameters notify the system to the action of the switches when contact is made. Select Reverse or Forward as required, then select the relevant operation.

Switch Makes - The switch closes on contact
Switch Breaks - The switch opens on contact
Ignore/Absent - The switch is missing, or should be ignored.

5.3.5 Advanced Tab

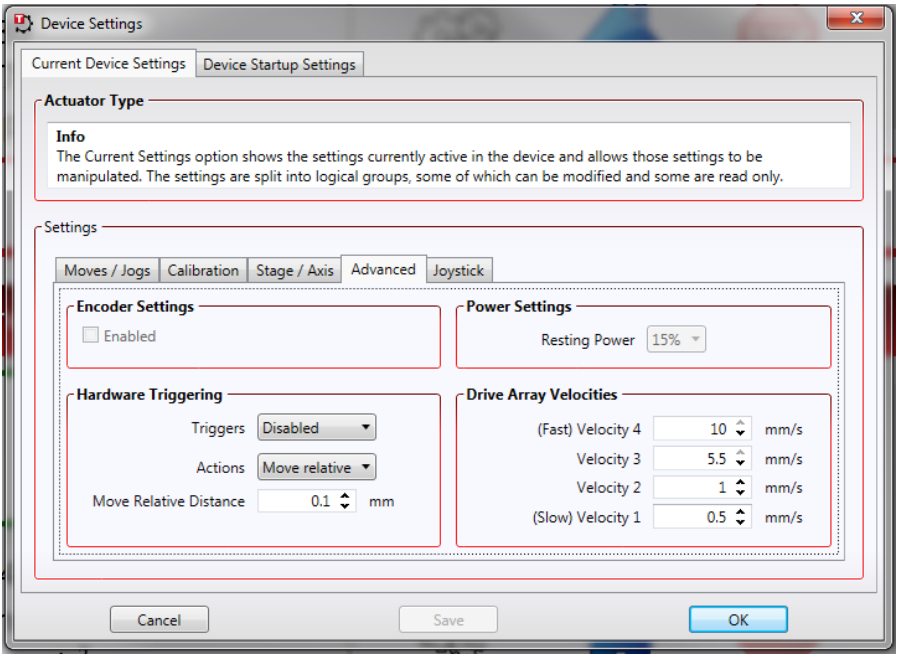


Fig. 5.8 Advanced Settings

Encoder Settings

Enabling the Encoder Settings will display another tab for use with Encoded stages. Please see the associated stage handbook for more details.

Hardware Triggering

Note

The move parameters for triggered moves can only be set via software method calls in software. Triggered moves cannot be set up via the GUI panel.

It is possible to configure a particular controller to respond to trigger inputs, generate trigger outputs or both respond to and generate a trigger output. When a trigger input is received, the unit can be set to initiate a move (relative, absolute or home). Similarly the unit can be set to generate a trigger output signal when instructed to move via a software (USB) command. For those units configured for both input and output triggering, a move can be initiated via a trigger input while at the same time, a trigger output can be generated to initiate a move on another unit.

The trigger settings can be used to configure multiple units in a master - slave set up, thereby allowing multiple channels of motion to be synchronized. Multiple moves can then be initiated via a single software or hardware trigger command.

Triggers

This parameter sets the trigger mode for the associated channel.

Disabled - triggering operation is disabled

Trigger In - a move (specified using the *Move Type* parameter below) is initiated on the specified channel when a trigger input signal (i.e. rising edge) is received on the Trig In pin of the rear panel CONTROL IO D-type connector - see Section 6.1. for pin out details.

Trigger In/Out - As for Trig In, but now a trigger output signal will also be generated on the Trig Output pin when the move begins - see Section 6.1. for pin out details.

Trigger Out - A trigger output signal is generated on the Trig Out pin when a move (relative, absolute or home) is initiated via software (either through the GUI panel or ActiveX method call).

Actions

This parameter determines the type of move to be initiated on the associated channel when a trigger input signal is detected on the Trig In or Trig Out connector.

Move Relative - triggered relative move. Relative move distance and velocity profile parameters can be set prior to triggering using the SetRelMoveDist and SetVelParams methods respectively.

Move Absolute - triggered absolute move. Absolute move position and velocity profile parameters can be set prior to triggering using the SetAbsMovePos and SetVelParams methods respectively.

Home - triggered home sequence. Homing parameters can be set prior to triggering using the SetHomeParams method.

For example, consider the following diagram:

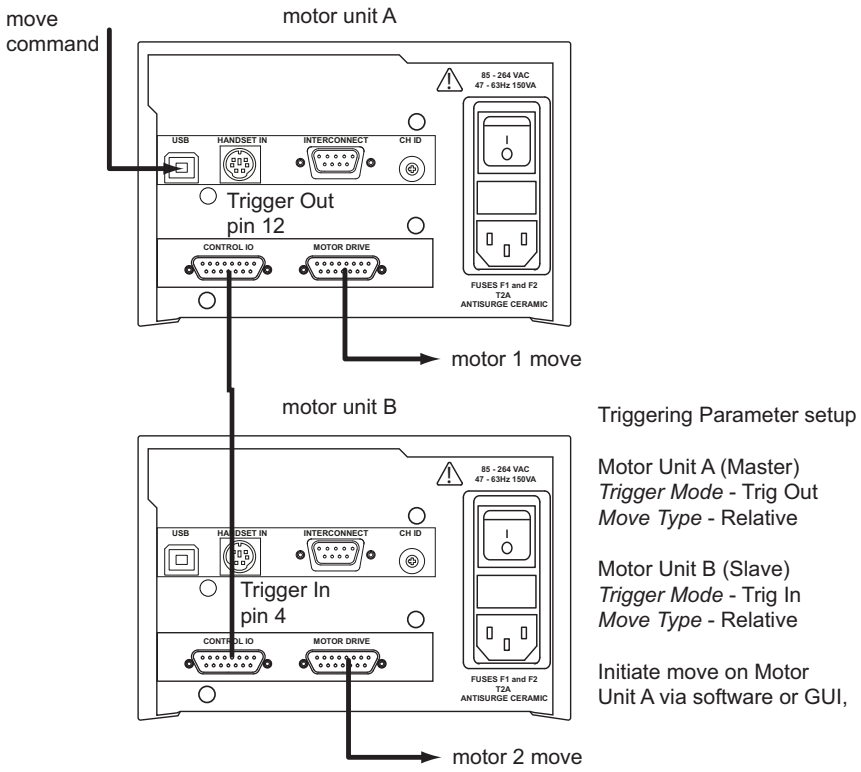


Fig. 5.9 Typical Triggering Set Up

When the move command is received via the USB link, the motor associated with unit A starts to move by the specified relative distance. Unit A also sends a trigger signal to Unit B. Unit B has been set to 'Trig In', so on receipt of the trigger from unit A, the associated motor also starts to move.

Power Settings

The BSC201 controllers are designed to vary the phase powers (current) in the motor coils depending on the operating state of the motor - moving or stationary. Typically, when a stepper motor is at rest it is advisable to reduce the phase (holding) currents so that the motor does not overheat. When moving, these phase currents are boosted to provide sufficient motor torque and minimise the possibility of stalling (missed

steps) The moving phase powers are set automatically by the unit and cannot be adjusted.

The Resting Power is entered as a percentage of full power.

Note

The default values applied by the software have been selected based on the type of stage or actuator associated with the motor drive. Modify these values with caution (particularly the rest power) as the risk of damage to the motor due to overheating is significant.

Drive Array Velocities

These parameters relate to the velocity for moves initiated by the DRIVE bar graph. Each specifies a velocity to apply when the associated bar is clicked. These settings are applicable in either direction of pot deflection, i.e. 4 possible velocity settings in the forward or reverse motion directions.

Note

It is acceptable to set velocities equal to each other to reduce the number of speeds.

5.3.6 Joystick Tab

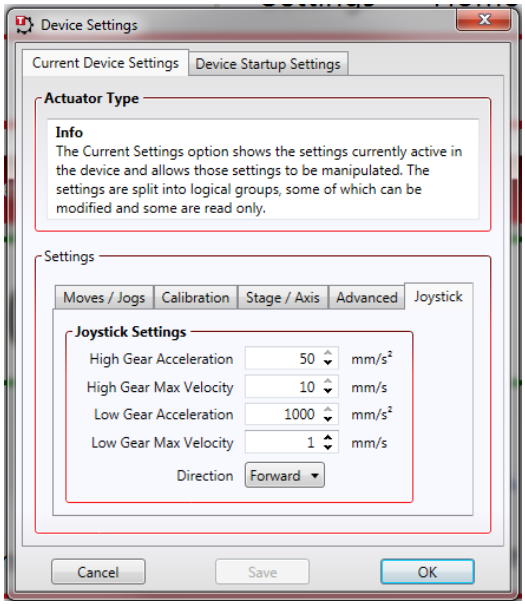


Fig. 5.10 Joystick Settings

Joystick Settings

If the optional Thorlabs joystick console is being used (MJC001) the following parameters are used to set the velocity and acceleration limits and the direction sense of any moves initiated from the joystick.- see Section 4.8. for more details on joystick use.

High Gear Acceleration – The acceleration of a move when high gear mode is selected.

High Gear Max Velocity – The max velocity of a move when high gear mode is selected.

Low Gear Acceleration – The acceleration of a move when low gear mode is selected.

Low Gear Max Velocity – The max velocity of a move when low gear mode is selected.

Direction – The actual direction sense of any joystick initiated moves is dependent upon the application. This parameter can be used to reverse the sense of direction for a particular application and is useful when matching joystick direction sense to actual stage direction sense.

Note

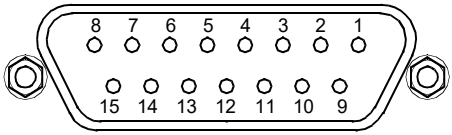
Joystick controlled moves always use a trapezoidal velocity profile.

Chapter 6 Rear Panel Connector Pinout Details

6.1 Rear Panel Control IO Connector

The 'CONTROL I/O' connector exposes a number of electrical signals useful for external control. It is possible to configure a particular controller to respond to trigger inputs, generate trigger outputs or both respond to and generate a trigger output - see Section 5.3.5. Motor jogging lines can be used to jog the motor in both forward and reverse directions from a remote handset (Jogging parameters (e.g. jog distance) are set via the GUI panel - see Section 5.3.2.).

The pin functions are detailed in Fig. 6.1.



Pin	Description	Return	Pin	Description	Return
1	User 5V I/O	9	9	User 0V	–
2	* Jog forwards	9	10	* Jog backwards	9
3	Not Used	9	11	** Analog In	9
4	Tigger In	–	12	Trigger Out	9
5	User 0V	–	13	Not Used	5
6	Not Used	–	14	Not Used	6
7	Digital (User) In	–	15	Digital (User) Out	9
8	Keyed Pin	–			

Notes

*** Jog inputs must be short circuit to User 0V (pin 9) in order to function.**

**** Analog In is 0 to 5V wrt 0V (pin 9). The input can be read by calling the a function in the software - see the *Kinesis API helpfile* for more details.**

Fig. 6.1 MOTOR I/O connector pin identification

6.1.1 Digital/User Outputs

All digital outputs are of the open-collector type, with a 330 Ohm series resistor. When the output is set to a logic zero (which is also the default state), it behaves as open circuit. When it is a logic one, it behaves as a 330 Ohm resistor connected to ground.

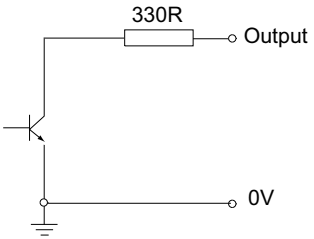


Fig. 6.2 Digital Output Schematic

In some applications, the outputs may be required to control external equipment that has optocoupler type inputs (such as PLCs). The digital outputs used here can be used to directly drive most optocouplers and the +5V supply available on pins 14 and 15 can be used to provide power for the optocouplers.

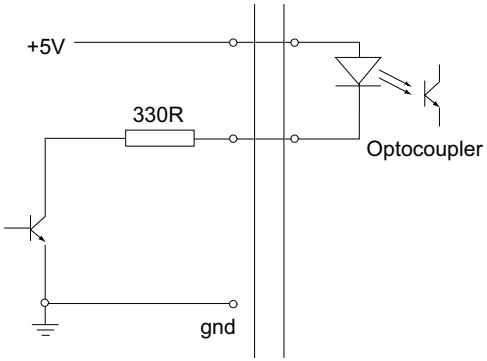


Fig. 6.3 Application Example: Connection to Optocoupler Inputs

These outputs can also be used to interface to external logic circuitry (a pull-up resistor may be needed if the external logic does not contain it) or control other types of inputs.

Caution

The voltage that external equipment applies to the digital outputs must be within the range 0 V and +5 V DC, or damage to the outputs may occur.

Please see the appropriate function in the Kinesis helpfile for details on how to control these logic IO.

6.1.2 Digital/User Inputs

The digital inputs used in the controller are of the standard CMOS logic gate type with TTL compatible input levels and a built-in pull-up resistor (10 kOhm to +5V). They can be connected directly to mechanical switches, open-collector type outputs or most type of logic outputs.

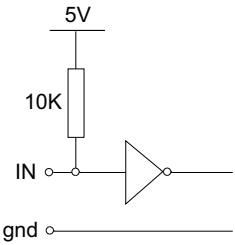


Fig. 6.4 Digital Input Schematic (protection circuitry not shown)

When connected to a switch, the inputs will read as logic LOW if the switch is open circuit and HIGH if the switch is closed. When connected to a logic output, or any other voltage source, the input is guaranteed to read LOW if the voltage is above 2.4V and HIGH when the output is below 0.8 V. Please see the appropriate function in the Kinesis helpfile for details on how to control these logic IO.

Caution

The voltage applied to the digital inputs must be within the range 0 V to +7V DC, or damage to the inputs may occur.

6.1.3 Trigger Output

The trigger output is different from the rest of the digital outputs in that it is a 5V CMOS logic gate with a series 1 kOhm resistor for protection. It behaves as +5V voltage source with 1 kOhm in series when the outputs is a logic HIGH, and 1 kOhm to ground when it is a logic LOW. The 1 kOhm resistor limits the current to 5 mA maximum for any load as long as the output is not connected to voltages outside the 0 V to +5V range.

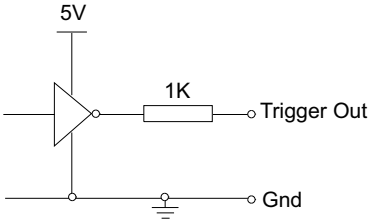


Fig. 6.5 Trigger Output Schematic

As this output is actively driven, it can be connected, for example, to an oscilloscope without a need for an external pull-up resistor. It can also be used to drive most optocouplers.

6.1.4 Trigger Input

The Trigger inputs are electrically identical to the digital inputs (i.e. a standard CMOS logic gate type with TTL compatible input levels and a built-in pull-up resistor, 10 kOhm to +5V). They can be connected directly to mechanical switches, open-collector type outputs or most type of logic outputs.

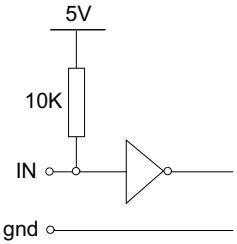


Fig. 6.6 Trigger Input Schematic (protection circuitry not shown)

When connected to a switch, the inputs will read as logic LOW if the switch is open circuit and HIGH if the switch is closed. When connected to a logic output, or any other voltage source, the input is guaranteed to read LOW if the voltage is above 2.4V and HIGH when the output is below 0.8 V.

Caution

The voltage applied to the trigger inputs must be within the range 0 V to +7V DC, or damage to the outputs may occur.

6.1.5 Jog Inputs

The jog inputs used in the controller are of the standard CMOS logic gate type with TTL compatible input levels and a built-in pull-up resistor (10 kOhm to +5V). They can be connected directly to mechanical switches, open-collector type outputs or most type of logic outputs.

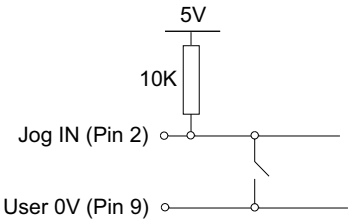


Fig. 6.7 Jog Input Schematic (protection circuitry not shown)

6.1.6 +5 Volt Supply

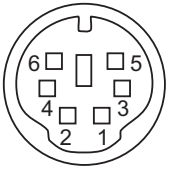
A +5 V, 250 mA supply is provided for interfacing to external circuits that require a power source.

Caution

Do not exceed the 250 mA maximum output current. For applications requiring higher currents an external power supply must be used.

6.2 Rear Panel HANDSET Connector

Provides connection to the MJC001 joystick. The pin functions are detailed in Fig. 6.8

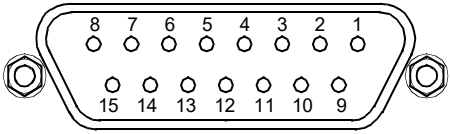


Pin	Description
1	RX (controller input)
2	Ground
3	Ground
4	+5V , 100 mA Supply for Joystick
5	TX (controller output)
6	Ground

Fig. 6.8 HANDSET Connector Pin Identification

6.3 Rear Panel MOTOR DRIVE Connectors

The ‘MOTOR DRIVE’ connector provides connection to the motors. The pin functions are detailed in Fig. 6.9. .



Pin	Description	Pin	Description
1	Encoder A +ve	9	CW Limit Stwitch
2	Encoder A -ve	10	CCW Limit Switch
3	Encoder B +ve	11	0V User
4	Encoder B -ve	12	For Future Use
5	5V User	13	For Future Use
6	For Future Use	14	Motor Phase B +
7	Motor Phase B -	15	Motor Phase A +
8	Motor Phase A -		

Fig. 6.9 DRIVE CHANNEL connector pin identification

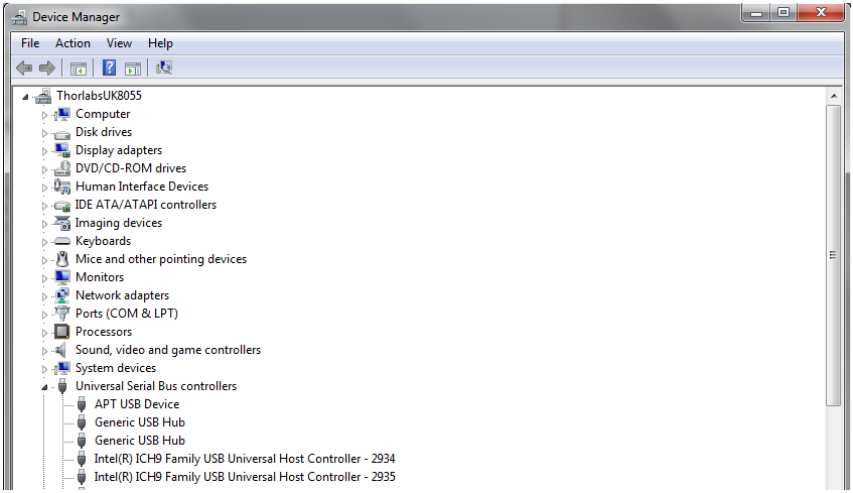
6.4 Rear Panel INTERCONNECT Connector

The INTERCONNECT terminal on the rear panel is for future development, and is not implemented at this time.

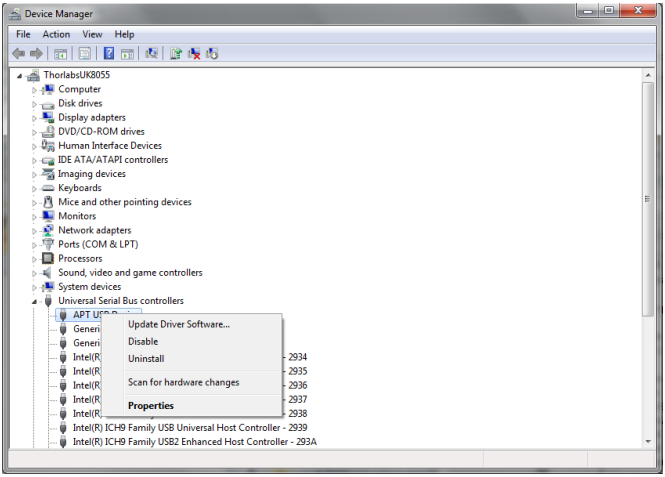
Chapter 7 Using A Virtual Comm Port

When using the low level communications protocol messages to develop client applications outside of the software, communication with the device is facilitated by using a virtual comms port can be configured as follows:

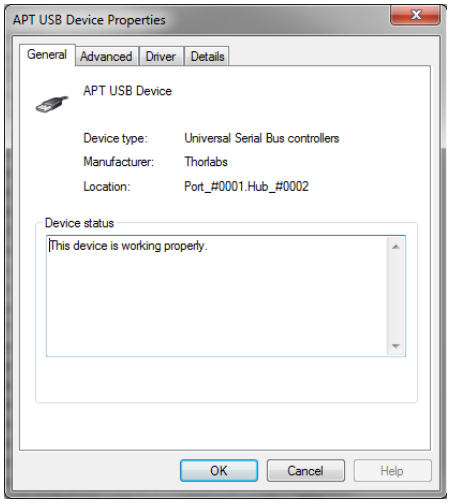
1) Open the device manager by selecting Start/Control Panel/Device Manager/



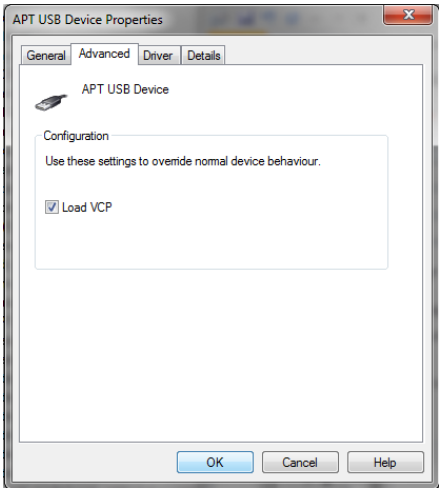
2) Click ‘USB Serial Bus Controllers’ and select the USB Device to be configured, then right click and select ‘Properties’.



3) The ‘USB Device Properties’ window is displayed.

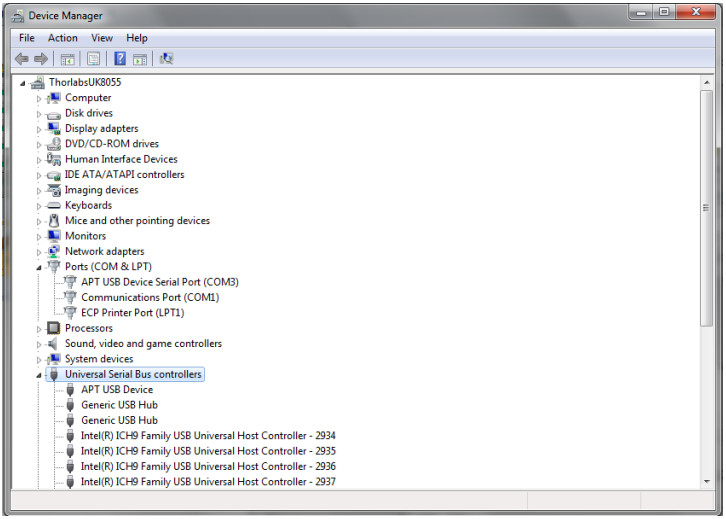


4) Select the ‘Advanced’ tab, and check the ‘Load VCP’ box.



5) Click OK, then power cycle the device being configured.

6) In the device manager, click ‘Ports (COM & LPT)’, and note the ‘USB Device Serial Port’ COM port number (e.g. COM3).



This COM port can then be used by the client application to communicate with the device using the low level protocol messages.

Chapter 8 Preventive Maintenance

Shock 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 remove its covers or attempt any repairs or adjustments. Maintenance is limited to safety testing and cleaning as described in the following sections.

8.1 Safety Testing

PAT testing in accordance with local regulations, should be performed on a regular basis, (typically annually for an instrument in daily use).

Caution

The instrument contains a power supply filter. Insulation testing of the power supply connector should be performed using a DC voltage.

8.2 Cleaning

The fascia may be cleaned with a soft cloth, lightly dampened with water or a mild detergent.

Warning

Disconnect the power supply before cleaning the unit.

Never allow water to get inside the case.

Do not saturate the unit.

Do not use any type of abrasive pad, scouring powder or solvent, e.g. alcohol or benzene.

Chapter 9 Specifications and Associated Parts

9.1 Specifications

Parameter	Value
Input/Output	
Motor Drive Channel (15-Pin D-type Female)	2-Phase Bipolar Motor Drive Output Differential Quadrature Encoder Interface Forward, Reverse Limit Switch Inputs
Motor Control (15-Pin D-type Female)	Jog Forward Jog Back User Outputs/Inputs Single - ended analog input (0-10 Volt) Trigger In/Out
Resolution	2048 Microsteps per Full Step 200 Step Motor - 409600 Microsteps per Rev
Motor Power	Up to 48 V/50 W (peak)
Input Power Requirements	
Voltage	85-264 VAC
Power	100 W
Fuse	3.15 A
Motor speeds	Up to 3000 RPM (for 200 full step motor)
Encoder feedback bandwidth	500,000 counts/sec
General	
Housing Dimensions (W x D x H)	152 x 244 x 104 mm (6 x 9.6 x 4.1 in.)
Instrument Weight	3.18 kg (7 lbs)
Compatible Motors	
Peak Powers	15 to 50 W
Average Power	25 W Maximum
Step Angle Range	20° to 1.8°
Coil Resistance (nominal)	4 to 15 Ω
Coil Inductance (nominal)	4 to 15 mH
Rated Phase Currents (nominal)	100 mA to 1 A

9.2 Associated Products

Product Name	Part Number
Stepper Motor Actuator, 4mm travel	DRV001
Stepper Motor Actuator, 25mm (1”) travel, trapezoidal leadscrew	DRV013
Stepper Motor Actuator, 50mm (2”) travel, trapezoidal leadscrew	DRV014
Stepper Motor Drive Cable (1.25 Metres)	PAA 610
Stepper Motor Drive Cable (3.0 Metres)	PAA 611

Chapter 10 Stepper Motor Operation - Background

10.1 How A Stepper Motor Works

J.1.1 General Principle

Thorlabs' actuators use a stepper motor to drive a precision lead screw.

Stepper motors operate using the principle of magnetic attraction and repulsion to convert digital pulses into mechanical shaft rotation. The amount of rotation achieved is directly proportional to the number of input pulses generated and the speed is proportional to the frequency of these pulses. A basic stepper motor has a permanent magnet and/or an iron rotor, together with a stator. The torque required to rotate the stepper motor is generated by switching (commutating) the current in the stator coils as illustrated in Fig. 10.1.

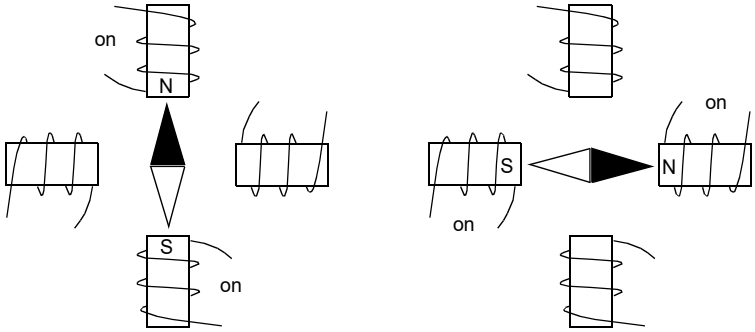


Fig. 10.1 Simplified concept of stepper motor operation

Although only 4 stator poles are shown above, in reality there are numerous tooth-like poles on both the rotor and stator. The result is that positional increments (steps) of 1.8 degrees can be achieved by switching the coils (i.e. 200 steps per revolution). If the current through one coil is increased as it is decreased in another, the new rotor position is somewhere between the two coils and the step size is a defined fraction of a full step (microstep).

The size of the microstep depends on the resolution of the driver electronics. When used with the Thorlabs BSC201 Stepper Motor Controller, the smallest angular adjustment is 0.000879 degrees (i.e. 1.8/0.000879 = 2048 microsteps per full step), resulting in a resolution of 409,600 microsteps per revolution for a 200 full step motor.

In practise, the mechanical resolution achieved by the system may be coarser than a single microstep, primarily because there may be a small difference between the orientation of the magnetic field generated by the stator and the orientation in which the rotor comes to rest.

10.1.2 Positive and Negative Moves

Positive and *negative* are used to describe the direction of a move. A positive move means a move from a smaller absolute position to a larger one, a negative move means the opposite.

In the case of a linear actuator, a positive move takes the platform of the stage further away from the motor.

In a rotational stage, a positive move turns the platform clockwise when viewed from above.

10.1.3 Velocity Profiles

To prevent the motor from stalling, it must be ramped up gradually to its maximum velocity. Certain limits to velocity and acceleration result from the torque and speed limits of the motor, and the inertia and friction of the parts it drives.

The system incorporates a trajectory generator, which performs calculations to determine the instantaneous position, velocity and acceleration of each axis at any given moment. During a motion profile, these values will change continuously. Once the move is complete, these parameters will then remain unchanged until the next move begins.

The specific move profile created by the system depends on several factors, such as the profile mode and profile parameters presently selected, and other conditions such as whether a motion stop has been requested. The profile mode can be set to 'Trapezoidal' or 'Bow Index' as described in Section 5.3.2.

The *Trapezoidal* profile is a standard, symmetrical acceleration/deceleration motion curve, in which the start velocity is always zero. This profile is selected when the *Bow Index* field is set to '0'.

In a typical trapezoidal velocity profile, (see Fig. 5.4.), the stage is ramped at acceleration '*a*' to a maximum velocity '*v*'. As the destination is approached, the stage is decelerated at '*a*' so that the final position is approached slowly in a controlled manner.

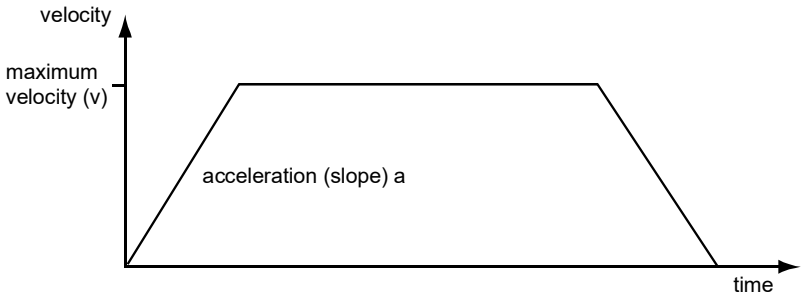


Fig. 10.2 Graph of a trapezoidal velocity profile

The *S-curve* profile is a trapezoidal curve with an additional '*Bow Value*' parameter, which limits the rate of change of acceleration and smooths out the contours of the motion profile. The *Bow Value* is specified in mm/s^3 and is derived from the Bow Index field as follows:

The *Bow Value* is applied in mm/s^3 and is derived from the Bow Index field as follows:

Bow Value = 2 $^{(\text{Bow Index } -1)}$ within the range 1 to 262144 (Bow Index 1 to 18).

In this profile mode, the acceleration increases gradually from 0 to the specified acceleration value, then decreases at the same rate until it reaches 0 again at the specified velocity. The same sequence in reverse brings the axis to a stop at the programmed destination position.

Example

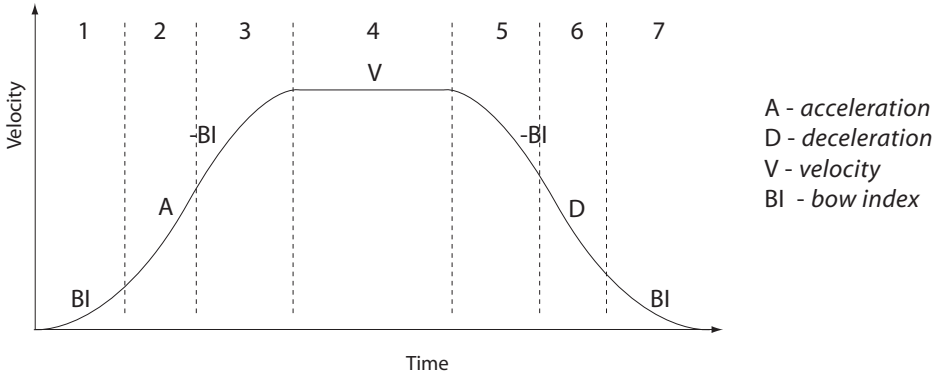


Fig. 10.3 Typical S-Curve Profile

The figure above shows a typical S-curve profile. In segment (1), the S-curve profile drives the axis at the specified Bow Index (BI) until the maximum acceleration (A) is reached. The axis continues to accelerate linearly (Bow Index = 0) through segment (2). The profile then applies the negative value of Bow Index to reduce the acceleration to 0 during segment (3). The axis is now at the maximum velocity (V), at which it continues through segment (4). The profile then decelerates in a similar manner to the acceleration phase, using the Bow Index to reach the maximum deceleration (D) and then bring the axis to a stop at the destination.

Note

The higher the Bow Index, then the shorter the BI phases of the curve, and the steeper the acceleration and deceleration phases. High values of Bow Index may cause a move to overshoot.

10.2 Positioning a Stage

10.2.1 General

Whenever a command is received to move a stage, the movement is specified in motion units, (e.g. millimetres). This motion unit value is converted to microsteps before it is sent to the stage. If operating the unit by the front panel (local mode) this conversion is performed internally by the controller. If operating via a PC (remote mode) then the conversion is performed by the software.

Each motor in the system has an associated electronic counter in the controller, which keeps a record of the net number of microsteps moved. If a request is received to report the position, the value of this counter is converted back into motion units.

10.2.2 Home position

When the system is powered up, the position counters in the controller are all set to zero and consequently, the system has no way of knowing the position of the stage in relation to any physical datum.

A datum can be established by sending all the motors to their 'Home' positions. The 'Home' position is set during manufacture and is determined by driving the motor until the negative limit switch is reached and then driving positively a fixed distance (zero offset). When at the Home position, the counters are reset to zero thereby establishing a fixed datum that can be found even after the system has been switched off.

See Section 4.2. for details on performing a Home move.

10.2.3 Limit Switches

A linear stage moves between two stops, and movement outside these limits is physically impossible. Linear stages can include stages that control the angle of a platform within a certain range, although the movement of the platform is not really linear but angular. Rotary stages can rotate indefinitely, like a wheel.

Linear and rotary stages both contain microswitches that detect certain positions of the stage, but they differ in the way these switches are used.

All linear stages have a –ve limit switch, to prevent the stage from accidentally being moved too far in the –ve direction. Once this switch is activated, movement stops. The switch also provides a physical datum used to find the Home position. Some linear stages and actuators also have a +ve limit switch , whereas others rely on a physical stop to halt the motion in the positive direction. A rotary stage has only one switch, used to provide a datum so that the Home position can be found. Movement is allowed right through the switch position in either direction.

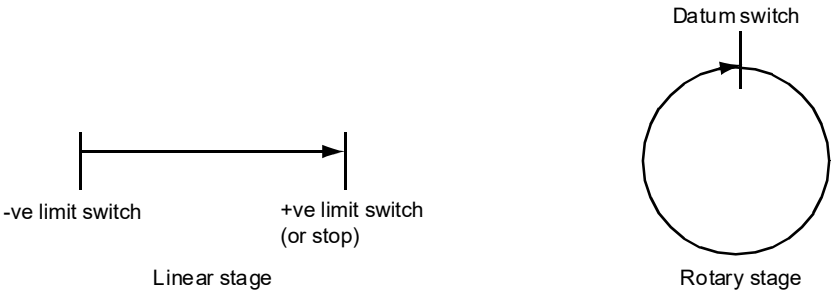


Fig. 10.4 Stage limit switches

10.2.4 Minimum and Maximum Positions

These positions are dependent upon the stage or actuator to which the motors are fitted, and are defined as the minimum and maximum useful positions of the stage relative to the 'Home' position - see Fig. 10.5.

The distance from the Minimum position to the Maximum position is the 'useful travel' of the stage. It is often the case that the Minimum position is zero. The Home and Minimum positions then coincide, with movement always occurring on the positive side of the Home position.

Rotary stages have effectively no limits of travel. The Minimum and Maximum positions are conventionally set to 0 and 360 degrees respectively. When the position of a rotary stage is requested, the answer will be reported as a number between 0 and 360 degrees, measured in the positive direction from the Home position.

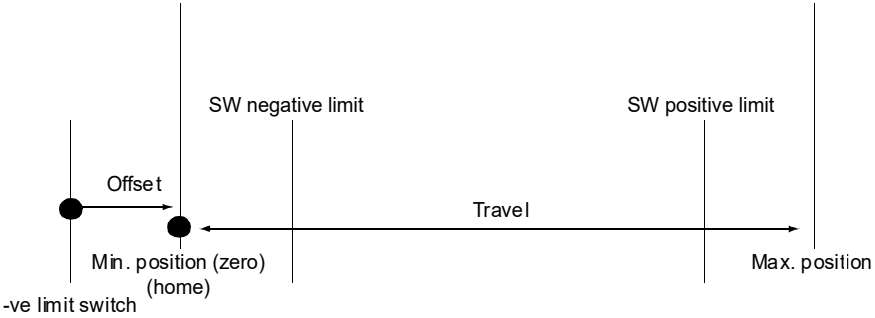


Fig. 10.5 Minimum and Maximum Positions

10.2.5 Power Saving

The current needed to hold a motor in a fixed position is much smaller than the current needed to move it, and it is advantageous to reduce the current through a stationary motor in order to reduce heating. Although this heating does not harm the motor or stage, it is often undesirable because it can cause thermal movements through expansion of the metal of the stage.

For this reason, power saving is implemented by default from the software drivers.

When a motor is moving, the 'Move Power' is applied. When a motor is stationary, the 'Rest Power' is applied. See 'Phase Powers' in Section 5.3.5. for more details on these power settings.

10.3 Error Correction

10.3.1 Backlash correction

The term *backlash* refers to the tendency of the stage to reach a different position depending on the direction of approach.

Backlash can be overcome by always making the last portion of a move in the same direction, conventionally the positive direction. Consider the situation in Fig. 10.6, a *positive* move, from 10 to 20 mm, is carried out as one simple move, whereas a *negative* move, from 20 to 10 mm, first causes the stage to overshoot the target position and then move positively through a small amount.

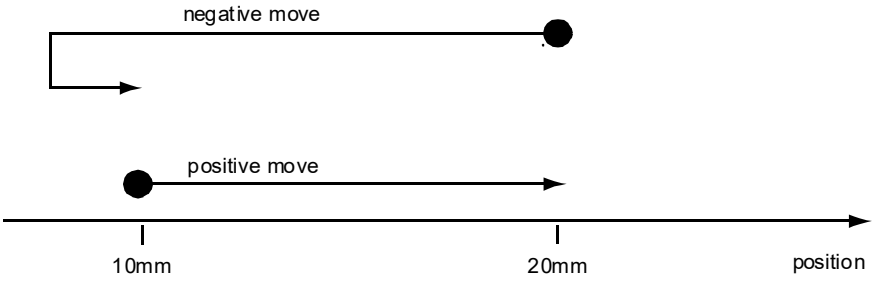


Fig. 10.6 Backlash correction

The controller has this type of 'backlash correction' enabled as its default mode of operation, but it can be overridden if the overshoot part of the move is unacceptable for a particular application.

See Chapter 5 for details on setting the backlash correction.

Chapter 11 Regulatory

11.1 Declarations Of Conformity

11.1.1 For Customers in Europe

See Section 11.3.

11.1.2 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.

11.2 Waste Electrical and Electronic Equipment (WEEE) Directive

11.2.1 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

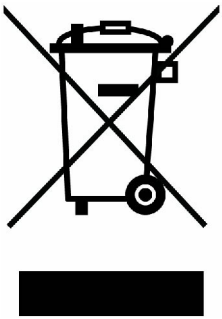


Fig. 11.1 Crossed out "wheelie bin" symbol

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.

K.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.

K.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.

11.3 CE Certificate



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):

2006/95/EC	Low Voltage Directive (LVD)
2004/108/EC	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: ***BSC201***

Equipment: ***Single Channel Benchtop Stepper Motor Controller***

is in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	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

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 August 2013

Name: Keith Dhese

Position: General Manager

EDC - BSC201 -2013-08-30

CE 13

Chapter 12 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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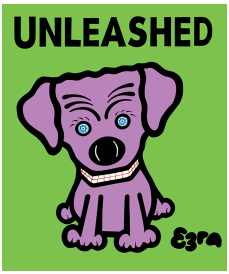
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