DOVER MOTION
A division of Invetech

SmartStage™ Linear Positioner User Guide

SMARTSTAGE™

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About This Guide

Introduction

This guide describes the installation of the SmartStage linear positioner and its operation. The intended audiences are software and hardware engineers, and technicians responsible for performing installation.

"About This Guide," covers the following topics.

Chapters and Appendixes in This Guide

This guide contains the following chapters. It does not cover advanced topics such as debugging the system or programming the controller.

About This Release

This version of the startup guide is for the SmartStage Linear product series.

Viewing the PDF version

The PDF version of this guide provides several ways to navigate through the content. Blue text indicates links to related topics. You can also do the following:

• Click the Bookmarks tab in the left pane to view the list of bookmarks and click any bookmark to navigate to that topic. If the Bookmarks tab is not visible, choose View > Navigation > Bookmarks from the menu bar.

• Click on the Contents bookmark. Pick any entry in the Contents and click either the entry text or its page number to go to that topic.

• Scroll to the end of the Contents to the List of Figures. Pick any entry in the list and click either the figure number and title or its page number to go to that topic.

• Scroll to the end of the List of Figures to the List of Tables. Pick any entry in the list and click either the table number and title or its page number to go to that topic.

• Click on the Index bookmark. Pick any index entry and click its page number to go to that topic.

Symbols

This guide uses the following symbols.

Note: Indicates neutral or positive information that emphasizes or supplements important points of the main text.

Caution: Advises users that failure to take or avoid a specified action could result in unintended operation.

Warning: Advises users that failure to take or avoid a specified action could result in physical harm to the user or hardware.

Contact Information

The business unit of Dover Motion in Boxborough, MA is the manufacturer of the SmartStage linear positioner and is located at the address:

Dover Motion

159 Swanson Rd.

Boxborough, MA 01719

The Dover Motion Website is located at:

http://www.dovermotion.com

If you have questions or comments, contact:

Phone: (508) 475-3400
Email: service@dovermotion.com

Chapter 1: Site Planning

Introduction

This chapter describes the responsibilities of the customer and the requirements for the installation site.

Topics

This chapter covers the following topics:

Unboxing the SmartStage linear positioner

Information for Receiving and Shipping Stop Removal

Receiving

When you receive your SmartStage linear positioner, do the following

1. Inspect the outer packaging for damage.

Figure 1 Single Axis SmartStage Linear Positioner Packaging

2. Carefully open the packaging containing the stage. Be sure to note any damage that may have resulted from shipping.

Specifications for Power, Communication, and Environment

Electrical Power

The specifications for the electrical power for SmartStage systems are as specified in Table 1.

Table 1 Specifications for Electrical Power per axis

Specification	
Recommended Supply Voltage	24-48V± 10%
Idle Power	<2W
Maximum Power Input	250W peak
Max Current Draw	5A (electronically limited)

Grounding

Certain types of electrical noise are greatly exaggerated by poor or improper electrical ground connections. Be sure to consider this when supplying power to the SmartStage linear positioner.

Warning: Do not connect the SmartStage linear positioner to the same dedicated line and ground that is used to power a device with a high current.

Warning: Use qualified personnel for installation of all electrical fixtures and ensure that all installations follow local bylaws.

Operating Environment

Table 2 lists the specifications for the environment in which the SmartStage will be fully operational and compliant with its performance specifications.

Table 2 Specifications for the Operating Environment

Specification	Acceptable Range
Temperature	0-40 °C
Storage Temperature	-20 °C to 85 °C
Maximum Humidity	90% non-condensing
Maximum operating altitude	2,000 m

Mounting

Holes in the base of the SmartStage are provided for mounting stage into an instrument or to another SmartStage for stacking. These holes are sized for M3 SHCS which can be tightened to 1.0Nm (for stainless steel hardware). Holes are also provided in the table. There are both M3 and M4 threaded holes. See dimension details for, location and depth of these holes. Fasteners threaded into the M3 tapped holes can be torqued to 1.0Nm, and 2.5Nm for the M4 tapped holes.

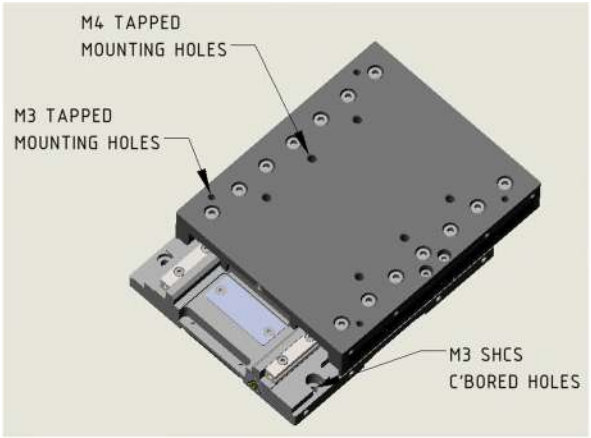


Figure 2 Mounting holes

Communications (RS-232, RS-485, and CAN) Setup

RS-232, RS-485, and CAN communication for the stage are DIP switch selectable. The communications switches are factory set based on the configuration ordered. See below for access and switch setting.

To access the communications setting switch, move the table toward the main connector side of the stage. Find the plate that covers the access hole for the switch and remove the two bolts using a M1.3 Hex Driver. To reinstall, use Loctite 220 on the screws and install the screws using 1.3mm hex driver. Torque the screws to 0.25Nm (3 in-lbs)

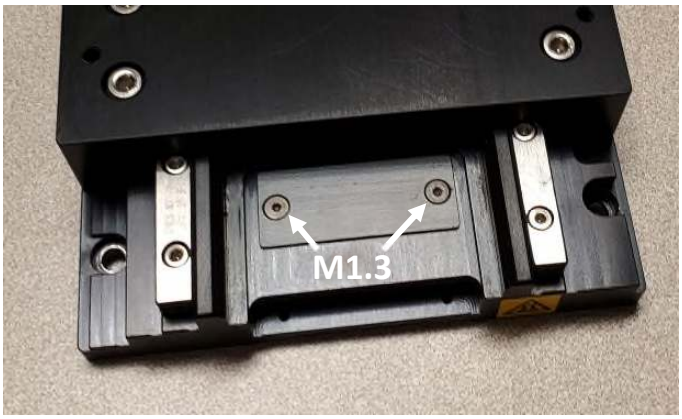


Figure 3 Switch Cover

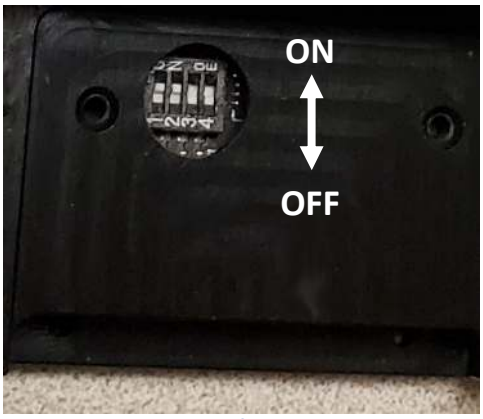
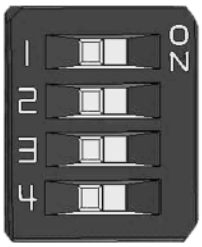


Figure 4 ON/OFF Switches

Table 3 Communication DIP Switch Definition

Description	Switch Setting				Switch
Position	1	2	3	4	
Name	CAN/SRL	485/232	LOZ/HIZ	HD/FD	
RS-232 Primary Axis	ON	ON	OFF	OFF	
RS-232 Secondary Axis	ON	ON	ON	ON	
RS-485 Low Z Full Duplex	ON	OFF	OFF	ON	
RS-485 Low Z Half Duplex	ON	OFF	OFF	OFF	
RS-485 High Z Full Duplex	ON	OFF	ON	ON	
RS-485 High Z Half Duplex	ON	OFF	ON	OFF	
CAN Low Z	OFF	X	OFF	X	

CAN High Z	OFF	X	ON	X	

RS-232

To communicate to the stage using RS-232, set switches 1 and 2 to the "ON". Switches 3 and 4 are set to OFF. The stage can handle all voltage types of RS-232 communication. The default baud rate for Smart Stage is 57600.

Note: When communicating with multiple stages over RS-232 in an XY stack, be sure that the DIP switches are set properly. One axis should be setup as the primary axis and the other should be setup as the secondary axis. If both are set the same the communication will not work.

RS-485

To communicate to the stage using RS-485, set switch 1 to the "ON" state and switch 2 to the "OFF" state. Switches 3 and 4 depend on your type of communication as detailed. The stage has the capability of communicating over either full duplex (4-wire) or half duplex (2-wire) for RS-485. This allows for communication to the on-board, integrated controls in both a point to point and multi-drop fashion. When there is only one system connected to a full duplex RS-485 bus, it is recommended that the user uses "point to point" mode to ignore all addressing during communication.

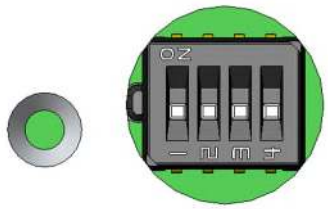


Figure 5 DIP Switch Selectable Communication

Multi-drop RS-485 communication may also be used in the SmartStage to allow serial commands to be sent by address. The on-board controller in the SmartStage has a default address of 1 for the lower axis and 2 for the upper axis (for XY setup). It is important to set the address of each SmartStage axis node to a unique value (range 0-255) or communication issues will arise.

Once every SmartStage on the RS-485 bus has been assigned a distinct address using the above steps, the hardware will need to be configured correctly before communication over the network is ready. It is important that all of the SmartStage linear axes, except the last system in the network, set DIP switch 3 to the "ON" state to provide high impedance to the communication line. The last system on the network should be set to the low impedance state to allow for proper communication at the highest baud rates.

CAN 2.0B

To communicate to the stage using CAN2.0B, set switch 1 to the "OFF" state. Switch 2 and 4 are ignored when in CAN mode and be set to any state. As with RS-485, only one SmartStage axis on a communication network should have switch 3 set to low Z.

Messages are transmitted and received using the standard format identifier length of 11 bits. All network messages that use the extended format 29-bit identifier are ignored. The data formats for the three message types are expressed in terms of the byte sequences for the parallel interface. Commands have varying data lengths; see the programming reference for more detail on individual commands. Bytes that are required regardless of the command sent are marked as such.

The default settings for the SmartStage linear positioner is a baud rate of 1Mbaud and Node ID address of 1 for the lower axis and 2 for the upper axis.

Termination resistors for RS485 and CAN work as described above.

Step & Direction Setup

The SmartStage can be set up to receive pulse and direction inputs to control the motion of the stage. See the SmartStage Programming guide for more information on setting up the pulse and direction inputs. The step and direction input lines expect TTL signals from 3.3.V to 5V. The maximum allowable frequency for the SmartStage is 4.8MHz and that rate should not be exceeded. In order to use Step and Direction mode, the I/O states must be factory configured for this mode, see the below Inputs and Outputs in the next section for more details.

Chapter 2: SmartStage Controller Usage

Introduction

This chapter covers the main features of the controller which is built into the stage, and best practices for implementation into a system. Programming the controller, setup and configuration for use with a motor or stage hardware will be reviewed.

Topics

This chapter covers the following topics:

SmartStage Linear Positioner Features

Incorporated Controller

SmartStage linear positioners have a built-in controller that allows the stages to operate without any external control hardware. Connect power and communications to begin running the stage. This means that the stage can fit in a much more compact area with all the same functionality.

Built-in Encoder and interpolator

The chrome-on-glass encoder scale that is built into the stage features a divide-by-n interpolator, allowing a finely adjustable interpolator resolution which cannot be changed in the field. The finest resolution setting is 5 nanometers, and this is the default set at the factory. To request other resolution options, contact a Dover Motion application engineer.

Advanced triggering (Trigger On Position) can be implemented to have a signal output at user programmable positions or at a user programmed fixed interval. The function of using the encoder position feedback signal to generate triggers on position at a specific spacing is done by the motion controller and these precisely spaced triggers are enabled by performing divide-by-n processing of the incoming quadrature encoder signals. One of the benefits of using the encoder based triggering is to provide digital quadrature signals at the right resolution to sync camera image capture and eliminate any image smear during scanning. The customized resolution can be downloaded to the encoder by using a dedicated cable and the encoder resolution be updated by the user to a new value when required. If you are interested in this functionality, please contact a Dover Motion application engineer.

Circuit breaker

The stages feature an on-board circuit breaker to protect from any surges in power or current draw from the stage itself. This will trigger automatically if the power input current exceeds 5A. This protection latches, and power must be removed from the stage to reset this fault. There is no software reset for this feature.

Multiplexed Inputs and Outputs

Each stage features an assortment of I/O for the user to make use of. Three are provided at for each axis in an XY stack. I/O includes:

- User controlled outputs
- Stage controlled outputs
- Trigger On Position
- Step and direction inputs to control motion
- Auxiliary encoder inputs to coordinate motion between axes

Coordinated Motion

User defined profile mode (UDP) allows stages to coordinate motion using auxiliary inputs. Stages can be driven by another axis or external source to follow defined motion curves based off the input.

Trigger On Position

Precision triggering based directly off the encoder position. This fires a 250ns pulse at programmed intervals or pre-defined coordinates along travel.

SmartStage Pinout Logic

The SmartStage linear stage electronics multiplex a variety of signals to the main connector I/O bank. This provides 3 unique I/O connections for each axis for a total of 6 in all. The following table summarizes the various states permitted. Additionally, axis specific combinations are shown for common use cases. The I/O is factory programmed, and is part of the configuration at time of order.

Understanding Permissible I/O States Table

Primary axis refers to the physical axis connected to the main 16 pin connector. This is typically the lower axis, but may also refer to a single axis stage. Secondary axis refers to the axis connected only via the 12 conductor high flex cable. This is typically the upper axis in a stacked configuration.

The primary axis utilizes the 3 IOA pins, while the secondary axis connects through the 3 IOB pins. As shown below, the multiplexer may simply pass through a signal on an I/O pin, change an input to an output, or map a signal from one axis to the other. The easiest way to choose the best Mux State is to find the best 'Use Case' for your application. The Dover Motion team is here to assist you in this process.

Table Guide:

Pass Through
Input
Output
Linked

GPIO Multiplexing States Available:

Table 4 GPIO Multiplexing States

	IOA1	IOA2	IOA3	IOB1	IOB2	IOB3	Use Case
Mux State 1	Q A2	Q B2	TOP G	P/T	P/T	P/T	IOA1 and IOA2 may be used as general purpose inputs, step and direction inputs, or for coordinated motion control (i.e. feedback signals). IOA3 may be used as a general purpose output or for LUT based output compare.
Mux State 2	Q A2	Q B2	A/O	P/T	P/T	P/T	IOA1 and IOA2 may be used as general purpose inputs, step and direction inputs, or for coordinated motion control (i.e. feedback signals). IOA3 may be used as a general purpose output only.
Mux State 3	Q A2 (from IOB2)	Q B2 (from IOB3)	A/O	P/T	L-IOA1	L-IOA2	This state links the secondary axis's position feedback to the primary axis's auxiliary encoder input. This allows the secondary axis to coordinate motion of the primary axis. In other words, the primary axis will follow a trajectory based on the instantaneous position of the secondary axis. IOA3 may be used as a general purpose output only. This state should be used on a primary axis with the secondary in state 5 or 6.

Mux State 4	Q A2	Q B2	A/O	Enc A (from IOA1)	Enc B (from IOA2)	P/T	This state links the primary axis's position feedback to the secondary axis's auxiliary encoder input. This allows the primary axis to coordinate motion of the secondary axis. Conversely to Mux State 3, the secondary axis will follow a trajectory based on the instantaneous position of the primary axis. IOA3 may be used as a general purpose output only. A primary axis in state 3 should be used with a secondary axis in state 1 or 2.
Mux State 5	Q A2	Enc A	Enc B	P/T	P/T	P/T	This state outputs the position feedback signals on IOA2 and IOA3. These signals can be used for coordinating motion on another axis. For example, the other axis may be in Mux State 3. IOA1 is a general purpose input.
Mux State 6	TOP	Enc A	Enc B	P/T	P/T	P/T	Similar to the previous state, this state outputs the position feedback signals on IOA2 and IOA3. These signals can be used for coordinating motion on another axis. For example, the other axis may be in Mux State 3. IOA1 may be used for TOP or as a general purpose output.
Mux State 7	TOP	TOP G	A/O	P/T	P/T	P/T	This state exposes both the TOP signal as well as the TOP gate signal on IOA1 and IOA2, respectively. The TOP gate signal is active high whenever the TOP signal is armed. The TOP gate signal could be used to enable an illumination source only during TOP triggered image acquisitions. IOA3 is a general purpose output.

I/O Functions Available (See Table 5 for the combinations and pins on which these can be available)

Table 5 I/O Functions Available

Name	Pin Name	Function	Notes/Description
P/T	Pass Through		
A/O	Axis Out	General purpose output	Use the signal sense register and the AxisOutMask to control the state of this output signal
TOP	Trigger on Position	Output position-based trigger pulse	250ns pulses fire on this output when trigger-on-position is configured to run, does not output with the stage using SPI encoder mode, this signal is AND'd with the gate signal, and will not output if the gate is low
TOP G	Trigger on Position Gate	Output gate signal for trigger pulses	Set high when trigger-on-position is configured and within the output range, this signal is AND'd with the trigger signal, therefore stopping the trigger signal if this is low
Enc A	Encoder A1	Main encoder output	This signal can be shared with other stages for coordinated motion, and is the encoder signal from the stage
Enc B	Encoder B1	Main encoder output	This signal can be shared with other stages for coordinated motion, and is the encoder signal from the stage
Q A2	Quadrature A2	Auxiliary encoder input	Used for coordinated motion, electronic gearing input and general purpose inputs

Q B2	Quadrature B2	Auxiliary encoder input	Used for coordinated motion, electronic gearing input and general purpose inputs

Primary Axis \ Secondary Axis	0	1	2	3	4	5	6	7
0	OK	OK	OK	OK	OK	OK	OK	OK
1	OK	OK	OK	OK	OK	OK	OK	OK
2	OK	OK	OK	OK	OK	OK	OK	OK
3	OK	OK	OK	BAD	BAD	BAD	OK	OK
4	OK	OK	OK	OK	OK	OK	OK	OK
5	OK	OK	OK	OK	OK	OK	OK	OK
6	OK	OK	OK	OK	OK	OK	OK	OK
7	OK	OK	OK	OK	OK	OK	OK	OK

Figure 6 Primary and Secondary Axis Stacked configuration settings

Main connector pinout

J1 - Main Connector

Pin	RS-232	RS-485	CAN
1	Secondary Axis I/O 3		
2	Secondary Axis I/O 1		
3	Primary Axis I/O 3		
4	Primary Axis I/O 1		
5	Digital I/O Return		
6	Primary Axis TX	Y	
7	Secondary Axis I/O 2		
8	Digital I/O Return		
9	Primary Axis I/O 2		
10	Secondary Axis RX	B	CANH
11	Primary Axis RX	A	CANL
12	Secondary Axis TX	Z	
B	Main Logic and Bus Supply		
A	Main Supply Return		

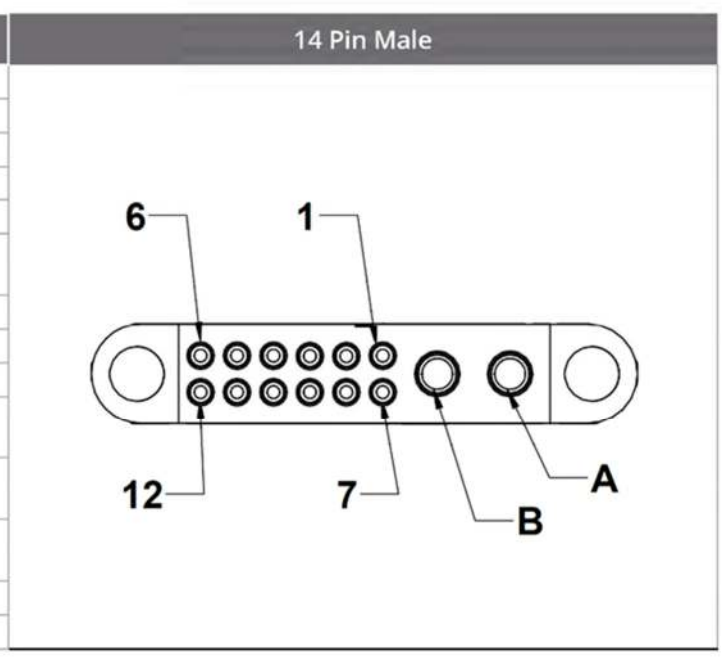


Figure 7 Main Connector Diagram

Configurator

See the configurator for part number detailed information

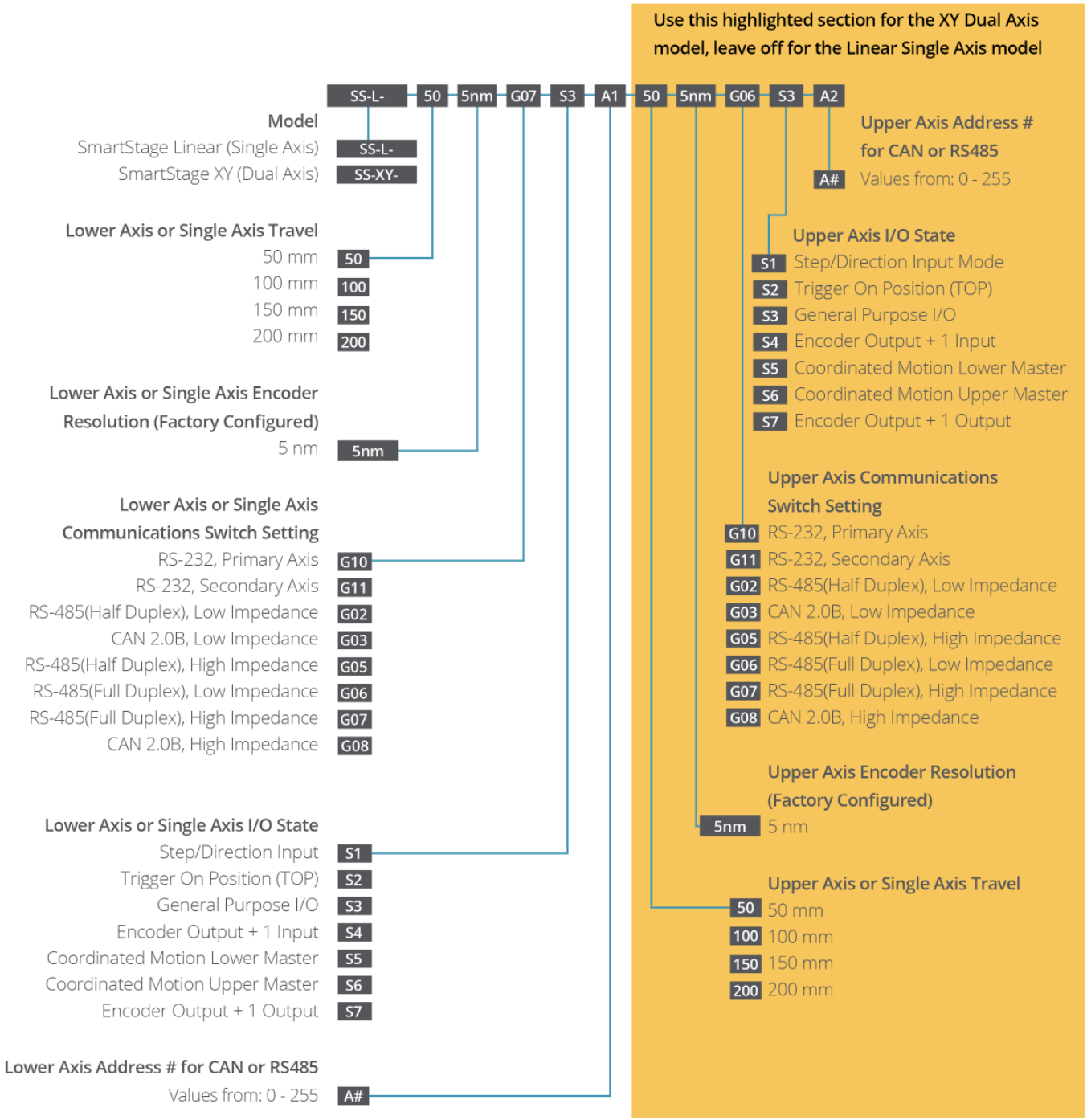


Figure 8 SmartStage Linear Configuration Settings

Specifications

See the Dover Motion website for the latest performance and motor specifications

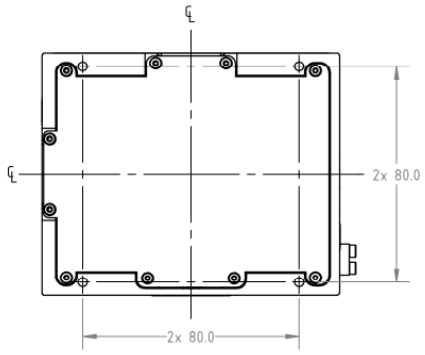
Mechanical Information

Table 6 SmartStage Linear Mechanical Specifications

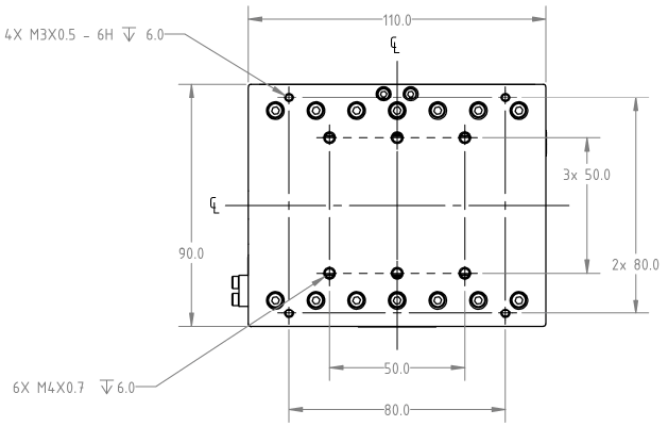
Specifications				
Travel (mm)	**50**	**100**	**150**	**200**
Weight(kg)	0.8	1.1	1.4	1.7
Width (mm)	90	90	90	90
Length (mm)	110	165	210	255
Height (mm)	25	25	25	25

SmartStage Linear 50 mm Travel Dimension Details

Bottom View



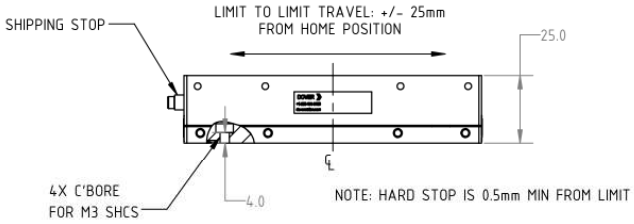
Top View



80 mm hole pattern in base and table is used for XY stacking

Front View

Side View



Specifications based on mounting base of stage to a surface with flatness of 0.005 mm

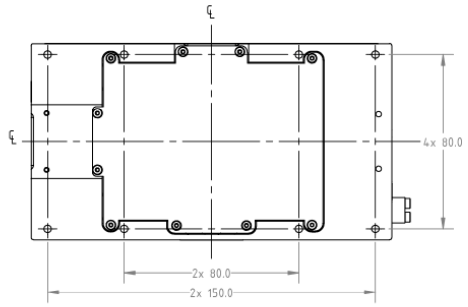
All dimensions are in millimeters [inches]

50mm Travel Stage

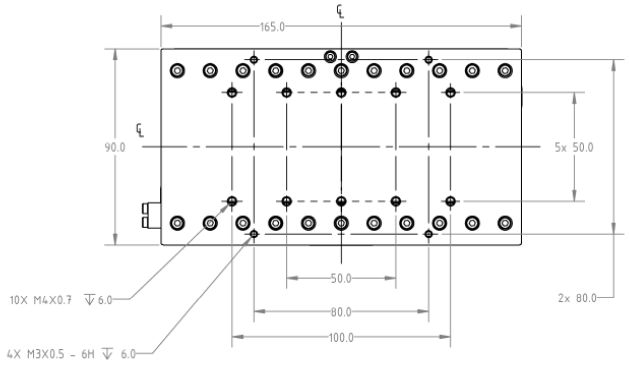
Figure 9 SmartStage Linear 50MM Dimension Details

SmartStage Linear 100 mm Travel Dimension Details

Bottom View

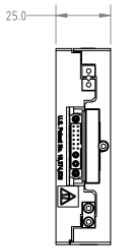


Top View

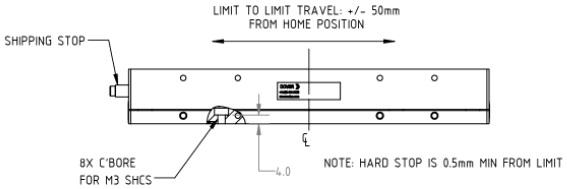


80 mm hole pattern in base and table is used for XY stacking

Front View



Side View



Specifications based on mounting base of stage to a surface with flatness of 0.005 mm

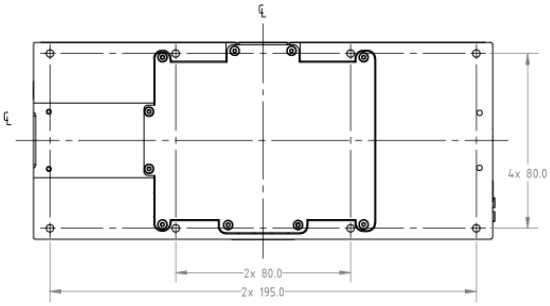
All dimensions are in millimeters [inches]

100mm Travel Stage

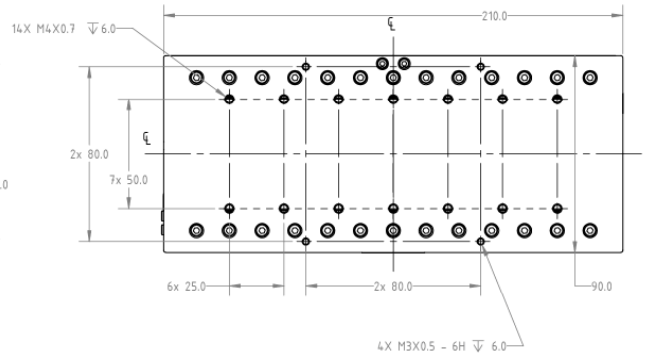
Figure 10 SmartStage Linear 100mm Dimension Details

SmartStage Linear 150 mm Travel Dimension Details

Bottom View



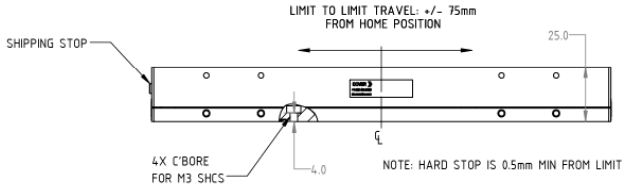
Top View



80 mm hole pattern in base and table is used for XY stacking

Front View

Side View



Specifications based on mounting base of stage to a surface with flatness of 0.008 mm

All dimensions are in millimeters [inches]

150mm Travel Stage

Figure 11 SmartStage Linear 150 mm Travel Dimension Details

SmartStage Linear 200 mm Travel Dimension Details

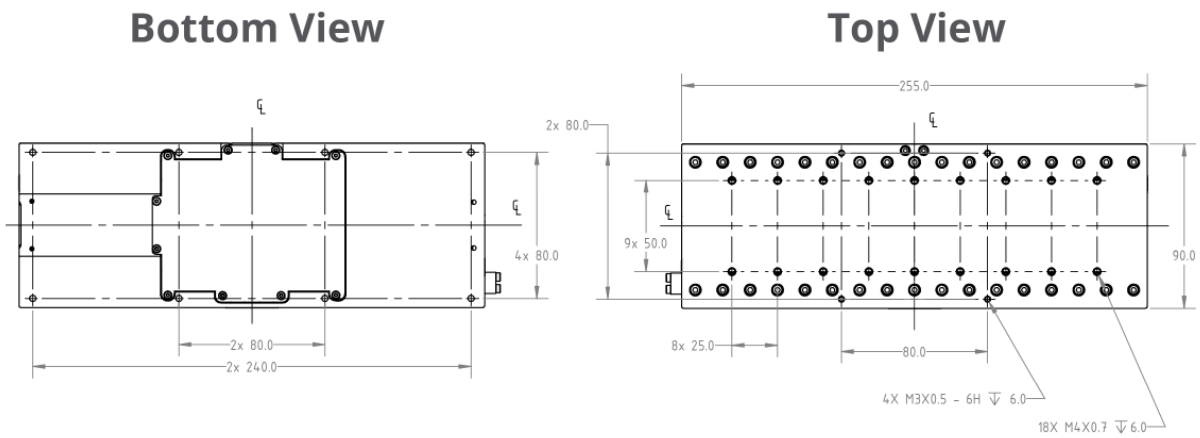


Figure 12 SmartStage Linear 200 mm Travel Dimension Details

Connector Pinout

J1 - Main Connector

Pin	RS-232	RS-485	CAN
1	Secondary Axis I/O 3		
2	Secondary Axis I/O 1		
3	Primary Axis I/O 3		
4	Primary Axis I/O 1		
5	Digital I/O Return		
6	Primary Axis TX	Y	
7	Secondary Axis I/O 2		
8	Digital I/O Return		
9	Primary Axis I/O 2		
10	Secondary Axis RX	B	CANH
11	Primary Axis RX	A	CANL
12	Secondary Axis TX	Z	
B	Main Logic and Bus Supply		
A	Main Supply Return		

14 Pin Male

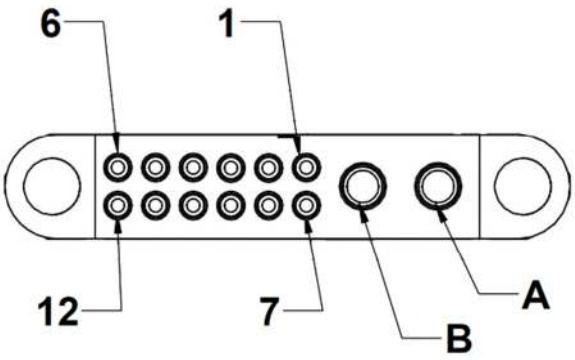


Figure 13 SmartStage Linear Connector PinOut Diagram

Interface cables for the SmartStage Linear

Interface cables and cable kits can be ordered with the SmartStage linear positioner. See the Dover Motion website datasheet for details on the latest available cables and communications kits.

Review/Revision History

Revision	Date	Summary	ECO number	Writer/ Reviser
A	10/30/2020	Initial Release	DM11145	Nanki Sahota
B	12/23/2020	Added updated drawings to the SmartStage XY dimension drawings section.	DM11351	Nanki Sahota
C	4/23/2021	Updated Pg21/22 pinouts	DM11556	Griffin Whittredge
D	12/2/2021	Added mounting fastener torque (page 15)	DM11901	Chris Lo