User Manual

A141D001 Rev 1.2
26-March-2020

A-141 Series Miniature Linear Air Bearing Stage

This document describes the A-141.xxxxx Series of Linear Air Bearing Motorized Stages.

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1. About this Document

1.1. Objective and Target Audience of this User Manual

This manual contains information on the intended use of the A-141 series of linear motor-driven air bearing stages. It assumes that the reader has a fundamental understanding of basic servo systems as well as motion control concepts and applicable safety procedures.

1.2. Symbols and Typographic Conventions

The following symbols and markings are used in this User Manual:

Symbol	Meaning
	If not avoided, the situation could result in damage to the equipment.
	Failure to observe these precautions could result in serious injury to those performing the procedures and damage to the equipment.
1. 2.	Action consisting of several steps whose sequential order must be observed
➢	Action consisting of one or several steps whose sequential order is irrelevant

1.3. Other Applicable Documents

None at this time

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2. Safety

2.1. Intended Use

The A-141 is a laboratory device as defined by DIN EN 61010. It is intended to be used in interior spaces and in an environment which is free of dirt, oil and lubricants.

In accordance with its design and realization, the A-141 is intended for single-axis positioning of loads at different velocities. The A-141 is not intended for applications in areas in which a failure would present severe risks to human beings or the environment.

The A-141 is intended for mounting only in which the plane of the stage tabletop is level and parallel to the plane of the ground. For orientations in which the motor must lift the payload against the force of gravity, a custom counterbalance is required.

The intended use of the A-141 is only possible when completely mounted and connected.

The A-141 must be operated with a suitable controller. The controller is not included in the scope of delivery of the A-141.

2.2. General Safety Instructions

The A-141 is built according to state-of-the-art technology and recognized safety standards. Improper use can result in personal injury and/or damage to the A-141.

- Only use the A-141 for its intended purpose, and only use it if it is in a good working order.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.
- The operator is responsible for the correct installation and operation of the A-141.

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2.3. Warnings and Safety Notices

The following statements apply throughout this manual. Failure to observe these precautions could result in serious injury to those performing the procedures and damage to the equipment. This manual and any additional instructions included with the stage should be retained for the lifetime of the stage.

 DANGER	To minimize the possibility of electrical shock and bodily injury or death, disconnect all electrical power prior to making any electrical connections.
 DANGER	To minimize the possibility of electrical shock and bodily injury or death when any electrical circuit is in use, ensure that no person comes in contact with the circuitry when the stage is connected to a power source.
 DANGER	To minimize the possibility of bodily injury or death, disconnect all electrical power prior to making any mechanical adjustments.
 DANGER	To minimize the possibility of bodily injury or death from electric shock in the case of malfunction or failure of the system, make sure a protective earth conductor is properly connected.
 DANGER	Moving parts of the stage can cause crushing or shearing injuries. All personnel must remain clear of any moving parts.
 WARNING	The stage table should never be moved without the air supply turned on. Moving the stage table with no air supply, causing sliding metal-to-metal contact, may damage the bearing surfaces.
 DANGER	Improper use of the stage can cause damage, shock, injury, or death. Read and understand this manual before operating the stage.
 DANGER	If the stage is used in a manner not specified by the manufacturer, the protection provided by the stage can be impaired.
 DANGER	Stage cables can pose a tripping hazard. Securely mount and position all stage cables to avoid potential hazards.
 DANGER	Do not expose the stage to environments or conditions outside the specified range of operating environments. Operation in conditions other than those specified can cause damage to the equipment.
 DANGER	The stage must be mounted securely. Improper mounting can result in injury and damage to the equipment.
 WARNING	Use care when moving the stage. Avoid any shocks, drops or bumps that can cause scratches, dings, dents, or distortion of the stage.
 WARNING	Dirt, oil, lubricants and condensation will damage the stage. Keep the stage clean and free of dirt, debris, oil, lubricants, and moisture.

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2.4. Organizational Measures

User manual

- Always keep this user manual available near the A-141.
- Add all information given by the manufacturer to the user manual, for example supplements or Technical Notes.
- If you pass the A-141 on to other users, also turn over this user manual as well as other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can result in minor injury and property damage.
- Only install and operate the A-141 after having read and understood this user manual.

Personnel qualification

The A-141 may only be installed, started up, operated, maintained and cleaned by authorized and appropriately qualified personnel.

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3. Product Description

3.1. Model Overview and Part Numbering

Model# A-141.035A1

Description: PIglide MB Miniature Linear Air Bearing Stage, 35mm Travel, 20µm Incremental Encoder with Sine (1 Vp-p) Output, 3-phase Linear Motor

3.2. Product Features

The A-141 series stage incorporates completely non-contact air bearing surfaces, linear motors, and feedback devices to provide a maintenance free stage. There is no mechanical contact to wear or require lubrication, making these stages ideal for clean room and medical applications. The A-141 incorporates opposing lateral and vertical preload. The brushless linear motor uses an ironless motor coil, which means there is zero cogging and no attractive forces – resulting in unsurpassed smoothness of motion. This is especially useful in applications where velocity control is important.

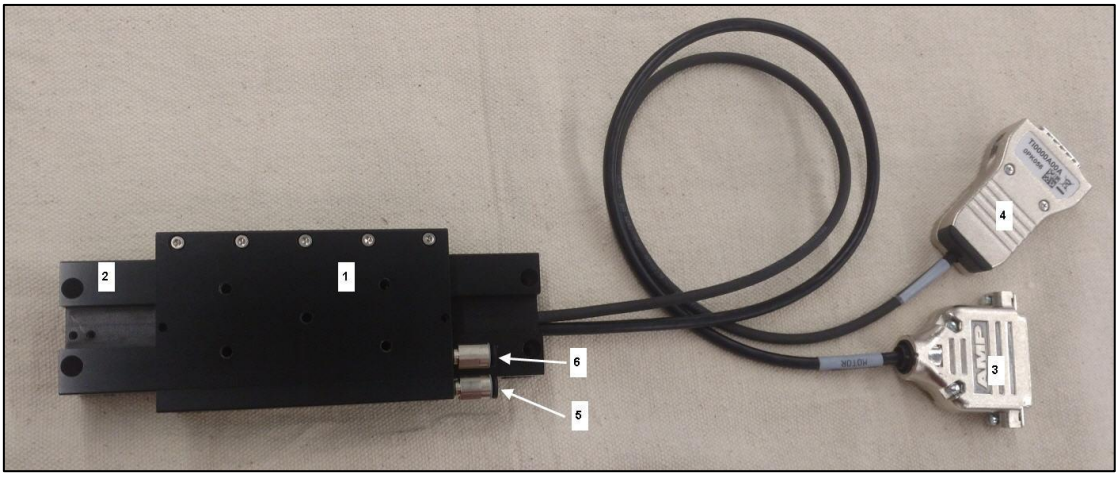

Figure 1 - Product Features, A-141

#	Description
1.	Moving table
2.	Stage base
3.	Motor electrical connection
4.	Encoder electrical connection
5.	Air supply inlet – Side & Bottom Air Bearing
6.	Air supply inlet – Vertical Lift Air Bearing

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3.3. Product Labeling

Figure 2 - Product Labeling Example

#	Description
1.	Product model number (example)
2.	Serial number (example), individual for each A-141 Meaning of the places (counting from left): A = PIglide Air Bearing Product 17 = year of manufacture (i.e. 2017) 242101 = unique number, 6-digit
3.	Warning sign "Observe manual"
4.	Old equipment disposal warning sign
5.	CE conformity mark
6.	Country of origin
7.	Manufacturer's address (website)
8.	Manufacturer's logo

3.4. Scope of Delivery

Item ID	Component
A-141.xxxxxx	Linear stage according to the order
---	Stage Mounting Screws (M6 x 40 SHCS)
---	Shipping restraint
A141D001	User manual (this document)

3.5. Accessories

The following accessories are offered to complement the A-141 stage. Contact PI for all available configurations.

Part #	Description
A-80x.xxx	Air Preparation and Filtration Kit
A-851.xxx	Cable sets for integration with various controllers

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3.6. Controllers

The A-141 must be connected to a suitable motion controller to be operated. The following standard controllers are available from PI to operate the A-141. Other controllers are also available, contact PI for options.

Part #	Description
C-891.120200	PIMag® Motion Controller for magnetic direct drives, 1 channel, 24 V, 3 A, USB and RS-232 interfaces
A-81x.xxxxx A-82x.xxxxx	PIglide/ACS Family of Motion Controllers (1, 2, 4, 6, or 8 Axes)

4. Technical Features

4.1. Air Bearing

The A-141 series stage features fully preloaded, non-contact, frictionless air bearings to guide the motion of the stage and support the payload. This air bearing is a highly accurate precision instrument. The non-contact nature of the air bearings will provide years of accurate and reliable use if treated properly. Keep the bearing clean and avoid any shocks, drops or bumps that can cause scratches, dings or distortion of the bearing.

The A-141 incorporates opposing lateral and vertical preload mechanisms. Be careful not to apply excess cantilever loads to the stage table.

4.2. Linear Motor

The A-141 series stage features a brushless, ironless linear 3-phase motor. This type of motor technology is completely non-contact and is ideally suited to fine resolution positioning and smooth, constant-velocity scanning. The motor must be commutated by an external motor drive. Hall Effect sensors are not included, so the drive and/or controller must be capable of encoder-based (sine) commutation.

4.3. Linear Encoder

The A-141 series stage features an optical non-contact linear encoder for direct measurement of the stage position. This feedback signal is used by an external motion controller to close the servo loop for position and velocity control.

The A-141 features an incremental encoder with analog (sine) output: Suitable for use with controllers using on-board encoder interpolation.

4.4. Limits and Index Mark

The A-141 series stage features non-contact limit switches and a home index marker. Both the limits and the index position are integral to the encoder electronics. The limits are magnetic and active high and are placed near the ends of travel. The index mark is optical.

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5. Unpacking and Handling

Carefully unpack the air bearing stage and other components from the shipping packaging. Inspect the contents for signs of damage. If there is any sign of damage or missing parts, contact PI immediately. Compare the package contents to packing list and notify PI immediately if any parts are missing or incorrect. Keep all packaging materials in case the product needs to be returned.

Before mounting or using the stage, it is recommended to let the stage stabilize at room temperature for at least 12 hours. Clean any dust or shipping debris off the stage by blowing it off with pressurized nitrogen or clean, oil-free air.

If the stage will be mounted in such a way as to block the product label, it is recommended to record the stage serial number for future reference.

	The A-141 stage must always be transported and shipped with the shipping restraint installed. Failure to use the shipping restraint when moving, transporting, or shipping the stage may allow movement between the stage table and stage base, causing damage.
	The stage table should never be moved without the air supply turned on. Moving the stage table with no air supply, causing sliding metal-to-metal contact, may damage the bearing surfaces.
	Use care when moving the stage. Manually lifting or transporting stages can result in injury.
	Use care when moving the stage. Avoid any shocks, drops or bumps that can cause scratches, dings, dents, or distortion of the stage.

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6. Installation

6.1. Mounting Surface Quality and Preparation

The A-141 is intended for horizontal mounting only in which the plane of the stage tabletop is level and parallel to the plane of the ground.

The mounting surface should be flat and have adequate stiffness in order to achieve the maximum performance from the A-141. When the A-141 series stage is mounted to a non-flat surface, the stage can be distorted as the mounting screws are tightened. This distortion will decrease the overall accuracy of the stage. Adjustments to the mounting surface must be done before the stage is secured. The effects of flatness on mounting are illustrated below.

To maintain accuracy, the mounting surface should be flat within 2µm. A laboratory grade AA granite surface plate is recommended. Do not shim under the stage base.

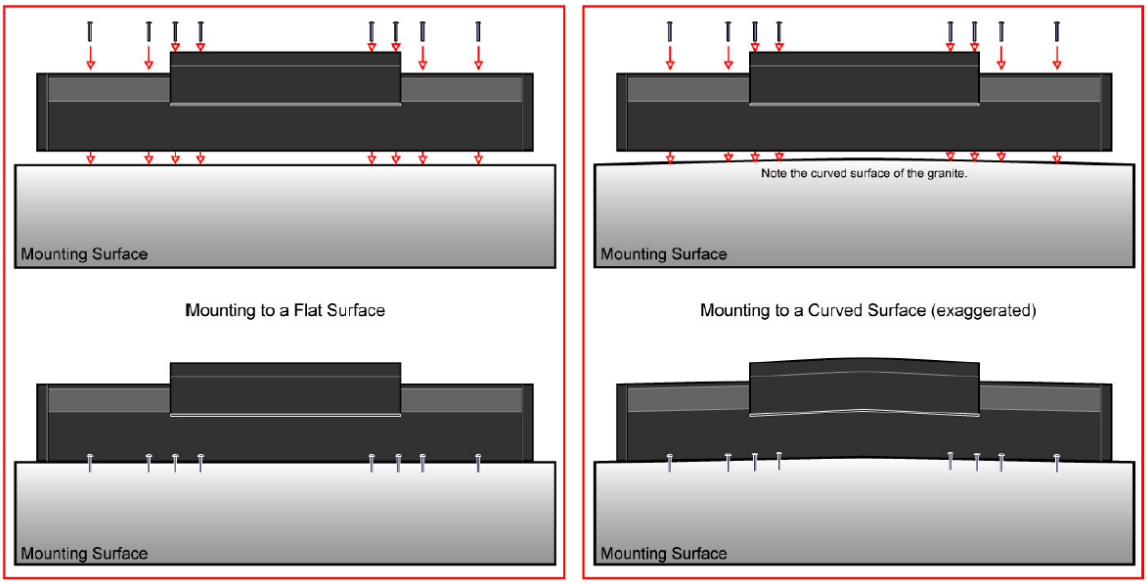

Figure 3 - Mounting Surface Quality

Prepare the mounting surface and bottom of the stage base with precision flat stones to remove any burrs or high spots. Clean the mounting surface and bottom of the stage with the appropriate cleaners (isopropyl alcohol).

6.2. Mounting Procedure

1. Place the stage on the mounting surface.
2. Connect the compressed air supply and turn on the air.
3. Remove the shipping restraint.
4. Affix the stage base to the mounting surface using 4x M3 SHCS x 20mm long (minimum).

The stage should now be securely mounted. Make sure to allow sufficient clearance at the end of the stage to attach the motor and encoder cables.

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6.3. Removing the shipping restraint

The stage is shipped with a shipping restraint installed to prevent unwanted motion between the stage table and the stage base. To remove the shipping restraint, unscrew the two (2) M2.5 pan head screws using a Philips head screwdriver. Make sure to safely store the parts for later use, in case the stage ever needs to be moved or transported.

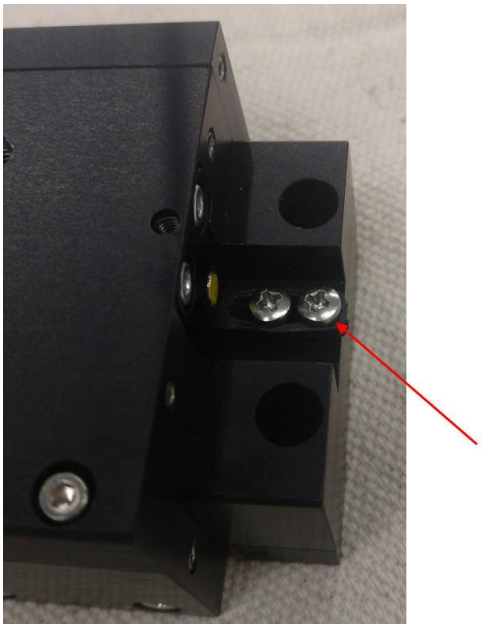

Figure 4 - Shipping Restraint

The shipping restraint kit for the A-141 consists of:

#	Description
1.	Shipping bracket for A-141 (1x)
2.	M2.5 Pan Head screws, 8mm Long (2x)

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6.4. Air Supply

Air Requirements

The A-141 stage requires clean, oil-free, and dry compressed air to operate properly. See Section 10.1 Basic Specifications for detailed air supply requirements.

It is recommended that a pressure switch is installed to monitor air supply pressure and to remove power from the stage motor if supply pressure drops below 40 psi to prevent damage to the air bearing surfaces.

Note that the air lines will move with the stage table. Take care to support the air lines in such a way that they exert minimum forces on the stage table so as not to affect the quality of motion.

The air inlet fittings on the A-141 stage accept flexible polyurethane pneumatic tubing, 4mm OD. The stage is equipped with two inlet fittings. One supplies air to the lateral/side air bearings along with the bottom preload bearing, the other supplies air to the top/lift bearing. The inlets are separated in this way in case the user wants to incorporate a self-lock feature. By turning the main top/lift supply on or off while keeping the side/bottom supply on, the stage position can be locked. This can be done while a servo loop in enabled. Contact PI for more information about using this feature.

In the case where a single air supply line is to be connected to the stage, use a T-fitting to tie the two 4mm OD lines together. In the photo below, a 2x 4mm to 1x 6mm tee is used.

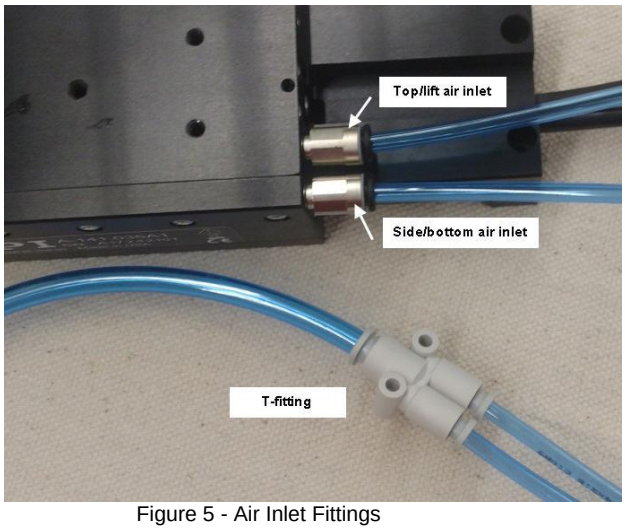

Figure 5 - Air Inlet Fittings

Turning off the air supply when not in use

When the stage is not in use, the air supply may be turned off to preserve compressed air and energy.

WARNING	The stage table should never be moved without the air supply turned on. Moving the stage table with no air supply, causing sliding metal-to-metal contact, may damage the bearing surfaces.

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6.5. Affixing the Payload to the Stage

The payload should be flat, rigid, and comparable to the stage in quality. For valid system performance, the mounting interface surface should be flat within 2µm.

The stage tabletop features 5x M4 tapped holes for mounting the user's payload. These are the only features that should be used to attach a payload to the stage.

Prepare the payload mounting surface and the stage table with precision flat stones to remove any burrs or high spots. Clean the payload mounting surface and the stage table with the appropriate cleaners (isopropyl alcohol).

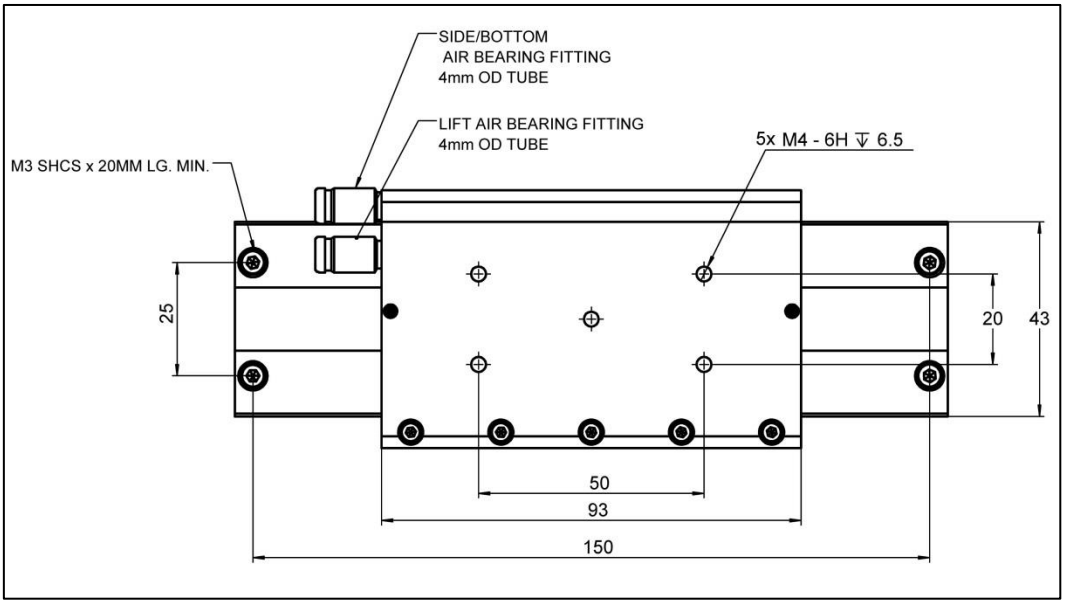

Figure 6 - Payload Mounting Holes

WARNING	Do not attempt to modify the stage table in any way. Customer modifications may damage the stage.
WARNING	The M4 screws used to attach the payload to the stage table should not thread into the stage tabletop any more than 6mm. Longer screws may damage the table.
WARNING	Do not overtighten the payload mounting screws.
WARNING	Do not exceed the maximum payload specified for the A-141 stage. Payload CG should not be cantilevered beyond the extents of the stage table.

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6.6. XY and Vertical Configurations

XY configurations of the A-141 series stage are not available at this time without customization. Please contact PI for a quote if you require a multi-axis stack.

Vertical configurations in which the motor is required to move against the force of gravity are not recommended using the A-141.

6.7. Connecting the Cables

Stage interconnect cables are not in the scope of delivery of the A-141 series stage. However, PI offers several standard cable sets that can be used, depending on the motion controller being used. Contact PI for a quote.

See Section 10.6 for connector pin assignments.

 WARNING	Only use the interconnect cables that have been designed for the combination of stage and controller being used. Connection using the wrong cable may result in damage to the stage and the controller.
 DANGER	To minimize the possibility of electrical shock and bodily injury or death, disconnect all electrical power prior to making any electrical connections.
 DANGER	To minimize the possibility of electrical shock and bodily injury or death when any electrical circuit is in use, ensure that no person comes in contact with the circuitry when the stage is connected to a power source.
 DANGER	To minimize the possibility of bodily injury or death, disconnect all electrical power prior to making any mechanical adjustments.

The stage electrical connectors are loose and not mechanically affixed to the stage, other than by the cables themselves (see Figure 1). We recommend securing the connectors in place with tie-wraps to the a secure, non-moving part of the installation to prevent them from moving once the stage has been installed.

1. Connect the stage cables for the motors and encoders to the connectors.
2. Tighten the jack screws with a flat head screwdriver to secure the cables. Do not overtighten the screws.

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7. Startup and Operation of the Stage

See the user's manual of the controller being used with the A-141 stage for instructions about startup and operation.

Note that the servo tuning values may need to be adjusted if the payload mass or size changes. If PI was not given user application information at the time of order, the servo was tuned with no (zero) payload mass.

 WARNING	Collisions can damage the stage and the payload. ➢ Take care when operating the stage to ensure that no collisions are possible between the stage, the load to be moved, and the environment in the motion range of the stage. ➢ Do not place any objects in areas where they can be caught by moving parts. ➢ Stop the motion immediately if a controller malfunction occurs.
 WARNING	Do not attempt to operate the stage with the shipping restraint installed.
 WARNING	The stage table should never be moved without the air supply turned on. Moving the stage table with no air supply, causing sliding metal-to-metal contact, may damage the bearing surfaces.
 WARNING	The drive mechanism of the A-141 is not self-locking. The stage can therefore unintentionally move in the following cases: ▪ Switching off or restarting the controller ▪ Switching off the servo mode for the axis Unintentional displacement can damage the stage, the payload to be moved, and the environment. ➢ Only operate the A-141 with a horizontally aligned motion axis. ➢ Before switching off or rebooting the controller, take suitable measures to ensure that no unintentional displacement of the stage table is possible.
 DANGER	Do not exceed the operating voltage range for which the A-141 is specified.
 WARNING	Causing the stage table to hit the hard stop with maximum speed and force can cause damage to the stage and the payload. ➢ Stop the motion immediately if a controller malfunction occurs. ➢ Ensure that the end of the travel range is approached at low velocity. ➢ Setup the motion controller to observe end of travel limits (if applicable). ➢ Determine the maximum velocity for your application. ➢ Set suitable soft limits for closed-loop operation on the controller.
 WARNING	The optimum values of the servo-loop parameters in the controller depend on the application and the payload mass. Unsuitable servo-control parameter settings of the controller can cause the control loop to become unstable and for the stage to vibrate. Oscillations can damage the stage and/or the load affixed to it. ➢ If the stage is oscillating or exhibits unusual operating noise, immediately switch off the servo mode for the axis on the controller or switch off the controller. ➢ Only switch on the servo mode for the axis on the controller after you have modified the servo-control parameter settings; see the manual of the controller. ➢ Note that the servo tuning values may need to be adjusted if the payload mass or size changes.

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8. Maintenance

Other than basic cleaning, the A-141 series stage is maintenance-free.

8.1. Cleaning the Stage

To clean the stage bearing surfaces, use isopropanol and a clean, lint-free cloth or wipe. Apply the cleaning agent to the cloth and wipe down all of the air bearing surfaces. When cleaning the air bearing it is recommended to leave the air supply turned on to help blow any particles out of the bearing and prevent particles from entering the nozzles. Be especially careful of fingerprints on the bearing surfaces as they attract dust and may tarnish the bearing finish.

 WARNING	Do not use cleaning agents other than isopropanol. Agents such as acetone or other detergents can damage certain parts of the stage.

8.2. Preparing the Stage for Transport

If the stage requires movement, transport, or shipping, follow these steps:

1. Turn off the controller power.
2. Disconnect stage cables.
3. Remove the payload.
4. With the air supply on, move the stage table to one end of travel by hand.
5. Install the shipping restraint.
6. Turn off the air supply and disconnect the air supply line from the stage.
7. Remove the screws used to mount the stage to the mounting surface.

The stage is now secured and can be safely moved. If the stage needs to be shipped, use the original packing materials.

 WARNING	Use care when moving the stage. Avoid any shocks, drops or bumps that can cause scratches, dings, dents, or distortion of the stage.
 WARNING	The stage table should never be moved without the air supply turned on. Moving the stage table with no air supply, causing sliding metal-to-metal contact, may damage the bearing surfaces.
 WARNING	Do not attempt to move or transport the stage with the payload attached. This may damage the stage and the payload.

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9. Customer Service

For inquiries and orders, contact your PI sales engineer or use the following contacts:

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Fax: 508-832-0506

If you have questions concerning your system, have the following information ready:

- Product codes and serial numbers of all products in the system
- Firmware version of the controller (if present)
- Version of the driver or the software (if present)
- Operating system on the PC (if present)
- If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

10. Technical Data

See the PI website for latest published specifications.

10.1. Basic Specifications

Model	A-141.035A1
Travel	35 mm limit-to-limit
Drive System	Brushless ironless linear servo motor, 3-phase
Feedback System	Non-contact optical linear encoder with travel limits and home index Sin/Cos, 1 V peak-peak, 20 µm signal period
Maximum Velocity (1)	250 mm/sec
Maximum Acceleration (1) (Unloaded)	3.5 m/sec^2
Maximum Payload (2)	Normal: 30 N
Maximum Moment Load (2)	Roll: 1.1 N-m Pitch 2.8 N-m
Accuracy (3) (with error compensation)	+/-0.2 µm
Repeatability	+/-0.1 µm
Straightness & Flatness (4)	< 0.2 µm over full travel
Pitch ,Yaw, & Roll (4)	< 10 µrad over full travel
Stage Mass	0.6 kg
Moving Mass	0.3 kg
Cabling	External, non-moving
Operating Pressure (5)	70 +/-5 psi (480 +/-35 kPa)
Air Consumption	< 1.0 SCFM (28 SLPM)
Air Quality	▪ Clean (filtered to 1.0 µm or better) - ISO 8573-1 Class 1 ▪ Oil-free -ISO 8573-1 Class 1 ▪ Dry (-15 °C dew point) - ISO 8573-1 Class 3
Construction	Hardcoat Aluminum SS Fasteners

Notes:
1. Maximum velocity and acceleration based on unloaded stage capability and may be limited by payload, controller, or drive performance.
2. Assumes an air bearing operating pressure of 70 psi (480 kPa. Stage is designed for horizontal operation only.
3. Accuracy is obtained with controller-based error compensation. The stage must be ordered with a controller from PI to reach these values. Accuracy values assume short-term duration and do not consider the long-term effects of thermal drift on the stage.
4. Dependent on the flatness of the surface to which the stage is mounted.
5. To protect stage from damage, an under-pressure air sensor tied to the controller E-stop input is recommended.

PI (Physik Instrumente) L.P.
16 Albert Street, Auburn, MA 01501
Tel: 508-832-3456 Fax: 508-832-0506
Email: air@pi-usa.us

10.2. Motor Electrical Specifications

Model	A-141.xxxx1
Bus Voltage	48 VDC nominal, 80 VDC max
Force Constant	2.1 N/A_{RMS}
Peak Current	1.1 A_{RMS}
Continuous Current	0.3 A_{RMS}
Peak Force	2.3 N
Continuous Force	0.58 N
Back EMF (phase-to-phase)	0.7 V/m/sec
Resistance (phase-to-phase)	22.4 Ω
Inductance (phase-to-phase)	1.0 mH
Electrical Cycle Length (pole pitch)	18 mm

10.3. Encoder Specifications

Type	Incremental
Resolution	20 µm signal period
Output Signal	Analog Quadrature 1 Vp-p, Differential
Power Input	5 VDC, <200 mA
Input Ripple	200 mVp-p max @ up to 500 kHz
Limits	Open collector output, Asynchronous pulse, Active high
Index Mark	0.8 to 1.2 Vp-p, Differential

10.4. Ambient Conditions

Area of use	For indoor use only
Vacuum Operation	This product is not compatible with operation in a vacuum environment.
Maximum Altitude	2000m
Relative humidity	40% to 60% non-condensing
Operating temperature [(1)]	+15°C to +25°C
Storage temperature	0°C to +40°C in original packaging
Dust Exposure	The A-141 series stage is not suited for dusty, dirty, oily, or wet environments.
Overvoltage Category	II
Protection Class	I
Degree of Pollution	1
Degree of protection according to IEC 60529	IP20

Notes:
1. For optimum performance, the stage should be operated at 20°C. Any deviation from this temperature could degrade the precision and performance of the stage. Any deviation outside the range shown above may damage the stage.

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10.5. Dimensions

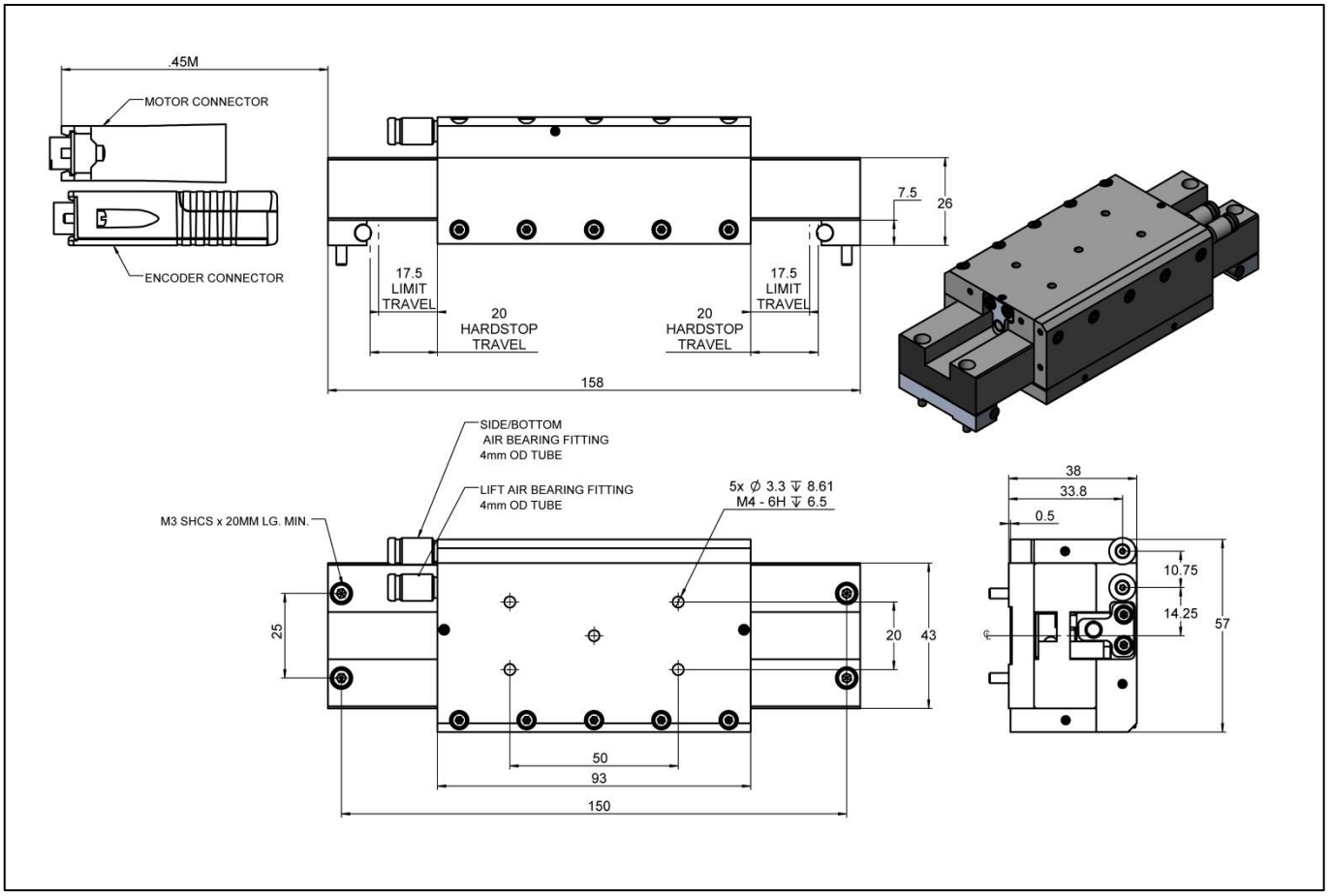

Figure 7 - A-141 Series Stage Dimensions

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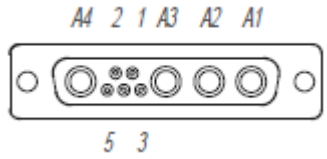
10.6. Pin Assignments

If a pin is not listed, assume it is N/C.

Motor Connector, Motor Option "1"

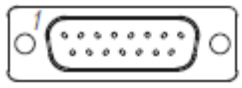
Type: DB9W4M



Pin	Function	Description
A1	PHA	Motor phase A
A2	PHB	Motor phase B
A3	PHC	Motor phase C

Encoder Connector

Type: DB15M



Pin	Function	Description
1	Cos-	Encoder Analog Cosine -
2	Sin-	Encoder Analog Sine -
3	Index+	Encoder Analog Reference +
4	+5v	Encoder power
5	+5v Sense	Encoder power sense line
6	Vx	Encoder Setup
7	Lim+	Open collector Limit+
8	Lim-	Open collector Limit-
9	Cos+	Encoder Analog Cosine +
10	Sin+	Encoder Analog Sine +
11	Index -	Encoder Analog Reference -
12	GND	Encoder ground
13	GND Sense	Encoder ground sense line
14	CAL	Encoder Calibration
15	N/C	

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11. EC Declaration of Conformity

For the model A-141 (all options and configurations), an EC Declaration of Conformity has been issued in accordance with the following European directives:

- 2004/108/EC, EMC Directive
- 2014/35/EU, Safety/Low Voltage Directive
- 2011/65/EU, RoHS Directive

The applied standards certifying the conformity are listed below.

- EMC: EN 61326-1:2013
- Safety/LVD: EN 61010-1:2010
- RoHS: EN 50581:2012

If an electrical operating device is designed to be integrated in another electrical operating device: The operator is responsible for a standards compliant integration of the electrical device into the overall system.

12. Old Equipment Disposal

In accordance with EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

Dispose of your old equipment according to international, national, and local rules and regulations.

In order to fulfil its responsibility as the product manufacturer, Physik Instrumente (PI) GmbH & Co. KG undertakes environmentally correct disposal of all old PI equipment made available on the market after 13 August 2005 without charge.

Any old PI equipment can be sent free of charge to the following addresses:

Physik Instrumente (PI) GmbH & Co. KG
Auf der Roemerstr. 1
D-76228 Karlsruhe
Germany

PI (Physik Instrumente) L.P.
16 Albert Street
Auburn, MA 01501
USA

PI (Physik Instrumente) L.P.
16 Albert Street, Auburn, MA 01501
Tel: 508-832-3456 Fax: 508-832-0506
Email: air@pi-usa.us