PIglide HB Hemispherical Air Bearings User Manual

Document# A-65XD0001

For the A-65X.XXX Series

Version 1.3 Date: 21-March-2019

This document describes the following products:

- A-651.045 PIglide HB Hemispherical Air Bearing, 50mm diameter, +/- 45° travel
- A-652.045 PIglide HB Hemispherical Air Bearing, 75mm diameter, +/- 45° travel
- A-653.045 PIglide HB Hemispherical Air Bearing, 100mm diameter, +/- 45° travel
- A-654.045 PIglide HB Hemispherical Air Bearing, 150mm diameter, +/- 45° travel
- A-655.045 PIglide HB Hemispherical Air Bearing, 200mm diameter, +/- 45° travel
- A-656.045 PIglide HB Hemispherical Air Bearing, 250mm diameter, +/- 45° travel
- A-657.045 PIglide HB Hemispherical Air Bearing, 300mm diameter, +/- 45° travel

and the following accessories:

- A-651.PED Pedestal for A-651.045 PIglide HB
- A-652.PED Pedestal for A-652.045 PIglide HB
- A-653.PED Pedestal for A-653.045 PIglide HB
- A-654.PED Pedestal for A-654.045 PIglide HB
- A-655.PED Pedestal for A-655.045 PIglide HB
- A-656.PED Pedestal for A-656.045 PIglide HB
- A-657.PED Pedestal for A-657.045 PIglide HB

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

Table of Contents

Table of Figures

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

1. Introduction

The PIglide HB Hemispherical Air Bearing is a family of passive air bearings that provide frictionless motion in three rotational degrees of freedom. Rotation about the vertical axis (Z) is unlimited. Rotation about the horizontal axes (X, Y) is limited to the travel range of the particular bearing model purchased (typically +/-45 degrees or less).

The PIglide HB series can be mounted with an optional pedestal base.

2. Warnings

WARNING: The air bearing should never be assembled or actuated without the air supply turned on. Assembling the bearing and sliding the hemisphere against the base, causing sliding metal-to-metal contact, may damage the bearing surfaces.

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.

3. Air Supply

A clean, filtered, regulated air supply is critical to proper operation of the bearing. We recommend the purchase of a PI Air Preparation Kit to be used with your air bearing.

We recommended filtering using 0.5 micron filters. Unless the air supply is from a dry nitrogen tank or other clean tank, coalescing filters or dryers should also be used to remove oil and water vapor. A regulator is recommended to optimize the air flow into the bearing for the application loading. The air bearing will operate with pressure ranging from 40 psi to 90 psi, depending on the load applied. As the operating pressure increases, load capacity and bearing stiffness increase. It is generally recommended to set the pressure between 75 – 80 psi. Operating at higher pressures will ensure margin for overloads, but the bearing will consume more air.

Air supply specifications:

- Operating Pressure: 80 psi (550 kPa) nominal, 90 psi (620 kPa) maximum
- Air Consumption: < 1.0 SCFM (28 SLPM)
- Air Quality: Clean (filtered to 1.0 µm or better) and oil-free. ISO 8573-1 Class 1.
- Air Humidity: Dry (0°C dew point). ISO 8573-1 Class 3.

4. Unpacking

Carefully unpack the air bearing 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. Keep all packaging materials in case the product needs to be returned.

Dispose of packaging materials according to environmental regulations.

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

5. Scope of Delivery

The system will include the following components:

1. Air Bearing Hemisphere (convex)
2. Air Bearing Base (concave)
3. Air fittings and tubing
4. Mounting hardware
5. Pedestal (optional accessory)
6. Air preparation kit (optional accessory, see separate User Manual)

6. Product Overview

A spherical air bearing provides frictionless motion in three degrees of freedom: unrestrained rotation about the vertical Z axis, and +/-45° tilt motion about the horizontal X and Y axes.

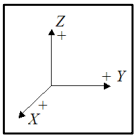


Figure 1 – Coordinate System

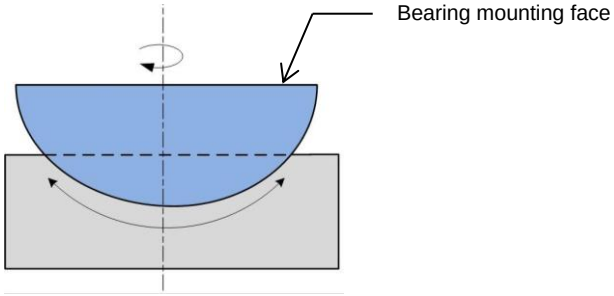


Figure 2 – Degrees of Freedom of the Spherical Air Bearing

7. Installation & Assembly

1. Mount the pedestal (if included) to a rigid, stable surface. It is important to ensure that the mounting surface can support the load of the pedestal, bearing, and payload to prevent tipping hazards, instabilities, or vibrations.
   a. If no pedestal is included, mount the air bearing base directly to a rigid, stable surface.
   b. If no pedestal is included, be careful not to block the air input port located in the bottom of the air bearing base. Contact PI if an alternate input port location is needed.
2. Route the air supply line for the bearing thru the access hole in the pedestal. Leave enough length to connect to the bearing.
3. Connect the air supply line to the air fitting located on the bottom of the air bearing base.
4. Mount the air bearing base to the pedestal using the hardware provided.
5. Mount the air preparation kit (if so ordered) in a location convenient to the facility compressed air supply and within 3 meters of the air bearing. If a longer air supply line run is needed, a larger diameter tube may be required. Contact PI if needed.
6. Connect the facility air supply to the input port of the air preparation kit.
7. Connect the air bearing supply tube to the output port of the air preparation kit.
8. Turn on the air supply and check that there is airflow coming out of nozzles in the air bearing base.
9. Adjust the pressure regulator knob on the air preparation kit until the pressure indicator dial reads the desired pressure (80 psi / 550 kPa is nominal).
10. Clean the air bearing base and hemisphere. (See cleaning instructions below).

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

11. With the air supply ON, gently place the air bearing hemisphere onto the base. It should float in the base with no friction.
12. Mount your payload to the air bearing hemisphere. The air bearing hemisphere may be removed from the base for this operation. Remember to always have the air turned on when placing the hemisphere in the base.

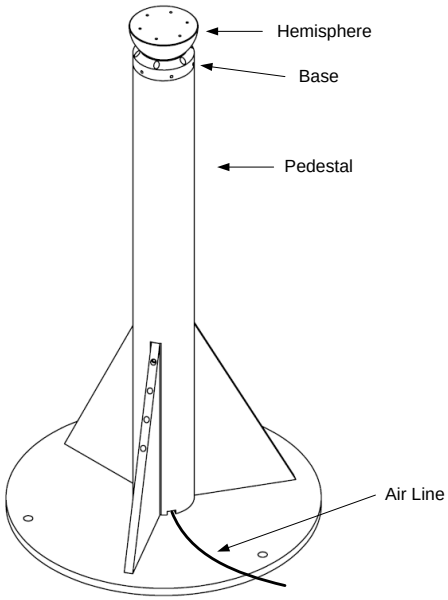


Figure 3 - Spherical Air Bearing and Pedestal Assembly

8. Moving the Air Inlet

The air inlet location can be changed by the user if needed.

In the standard factory configuration, the air fitting is installed in the bottom face of the bearing base, and the alternate port, located on the side of the base, is plugged with a sealed screw.

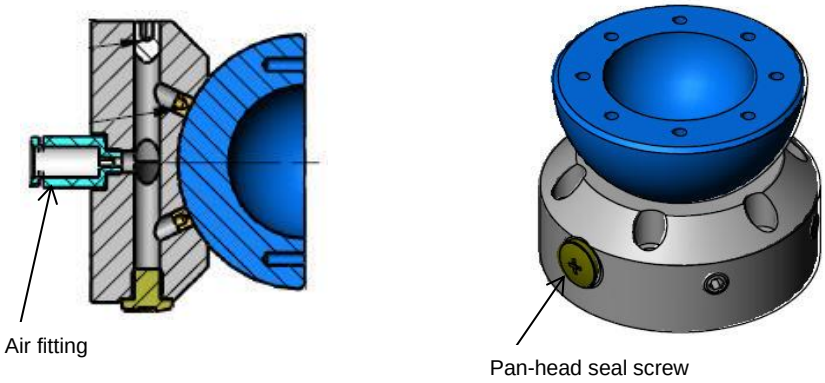


Figure 4 – Standard Factory Configuration

To change to the alternate location, simply swap the locations of seal screw and the air fitting. Make sure the air supply is turned off and the air line is disconnected before doing so.

1. To remove the air fitting, insert a 2.5mm Allen wrench inside the port and unscrew the fitting from the base by turning the wrench counter-clockwise.

Figure 5 – Allen wrench to loosen and tighten the air fitting.

2. Remove the seal screw from the side of the bearing base using a small Philips head screwdriver.
3. Install the air fitting into the alternate port on the side of the bearing. Carefully thread the fitting into the hole by hand, and then tighten using the Allen wrench. DO NOT OVERTIGHTEN.
4. Install the seal screw into the primary port on the bottom of the bearing base, and then tighten using the screwdriver. DO NOT OVERTIGHTEN.
5. Reconnect the air line and turn on the air supply.

9. Turbine Torque

All spherical air bearings with low friction exhibit turbine torque, where the air in the bearing has a preferential flow direction that will drive the sphere to accelerate in one direction. This is caused by the finishing process and small inconsistencies between the bearing orifices. Because these bearings are optimized to have the lowest friction possible (drag torque is typically on the order of 0.000002 Nm at a standstill), the bearings typically have a turbine torque larger than the drag torque, typically about 0.000005 Nm. The bearing will accelerate until the turbine torque matches the drag torque at that speed.

To minimize the turbine torque effect, we recommend reducing the supply air pressure until the bearing (with payload) touches down. Increase the pressure just until the bearing floats again, then increase by another 3-5 psi. This would be the minimum recommend operating pressure for that particular payload and will give the smallest possible turbine torque for that bearing and payload configuration.

Since the turbine torque is very consistent with a particular payload and air supply pressure, customers may typically run a calibration experiment to measure and null out the turbine torque from their test results.

10. Storage

When not in use, the air supply can be shut off and the bearing can still carry its design load. However, it is important to make sure that no sliding contact between the metal surfaces takes place.

Cover the bearing to prevent dust and other particles from accumulating on the exposed surfaces.

11. Cleaning

To clean the bearing, we recommend using isopropanol or acetone 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 base we recommend that you leave the air supply 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.

12. Specifications

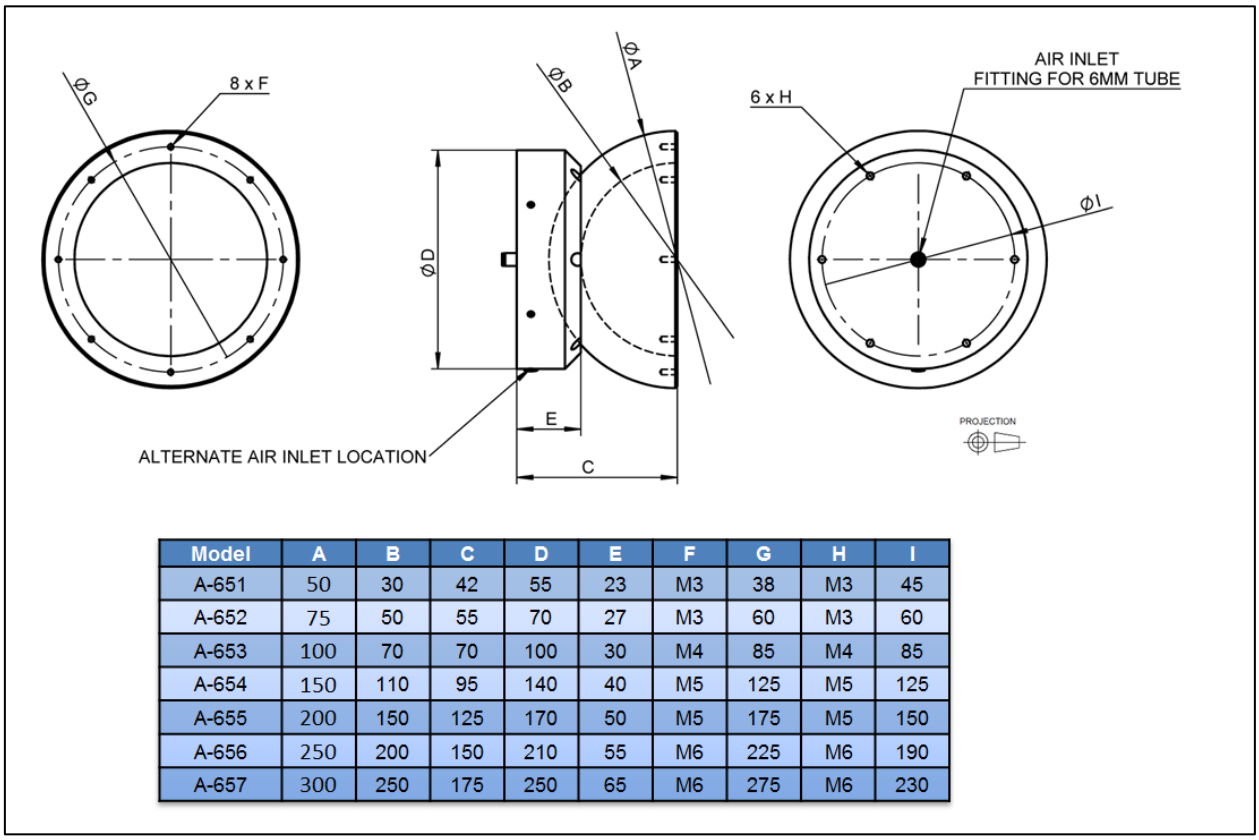
Model	Sphere Dia. (mm)	Travel (+/- °) [2]	Load Capacity (kg) [1]	Mass (kg)			Sphere Moment of Inertia ($g*m^2$)	
				Base	Sphere	Pedestal	About Z Axis	About Y Axis [3]
A-651	50	45	15	0.115	0.070	3.1	0.02	0.01
A-652	75	45	35	0.235	0.215	4.0	0.14	0.09
A-653	100	45	65	0.550	0.475	16	0.58	0.37
A-654	150	45	160	1.350	1.475	16	4.21	2.64
A-655	200	45	265	2.500	3.350	17	17.2	10.8
A-656	250	45	405	4.000	5.525	43	46.3	29.0
A-657	300	45	635	6.500	8.100	44	103	64.2

Notes:
1. Load capacities listed assume supply pressure of 80 psi. Contact PI to determine load capacity if alternate supply pressures are required.
2. Other travels available upon request. Contact PI for a quote for customizations.
3. About the bearing mounting face.

Construction Materials

Hardcoat aluminum, stainless steel fasteners
Alternate materials available upon request

Dimensions



Model	A	B	C	D	E	F	G	H	I
A-651	50	30	42	55	23	M3	38	M3	45
A-652	75	50	55	70	27	M3	60	M3	60
A-653	100	70	70	100	30	M4	85	M4	85
A-654	150	110	95	140	40	M5	125	M5	125
A-655	200	150	125	170	50	M5	175	M5	150
A-656	250	200	150	210	55	M6	225	M6	190
A-657	300	250	175	250	65	M6	275	M6	230

Figure 6 - A-65X Series Dimensions (mm)

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

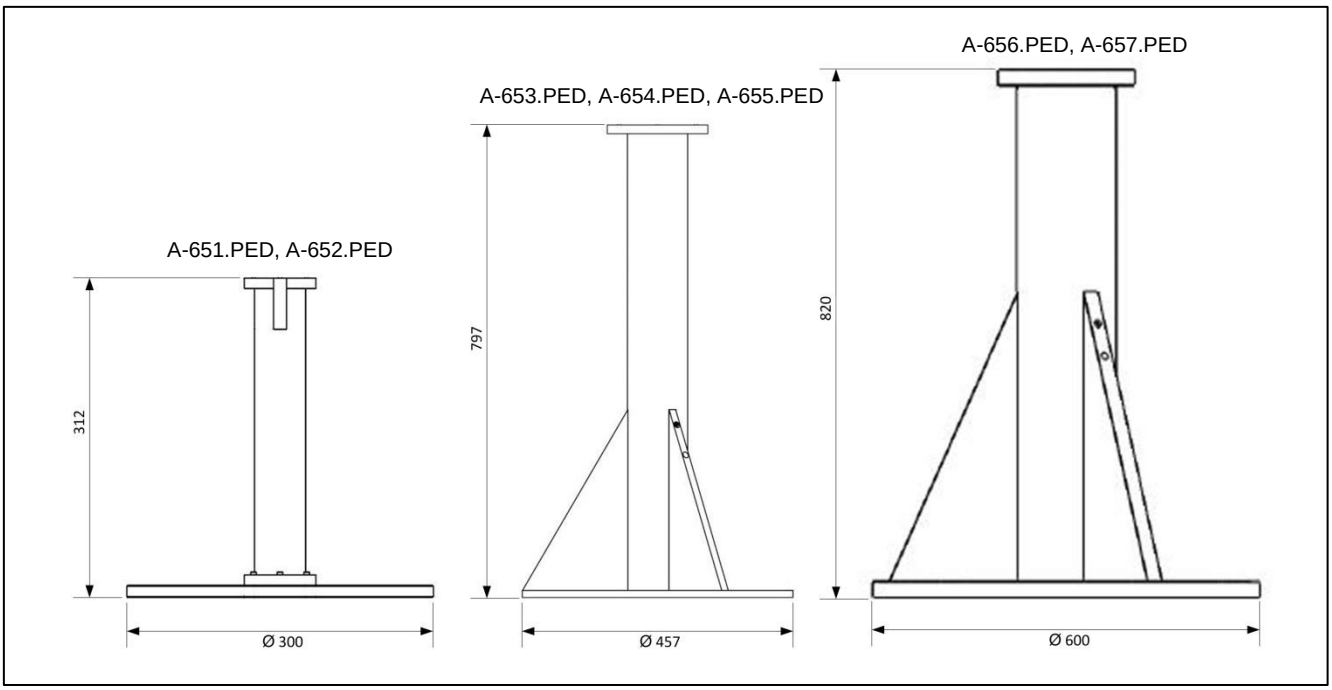


Figure 7 - A-65X.PED Pedestal Dimensions (mm)

13. Disclaimers

PI continually improves its product offerings, and listed options and specifications may be superseded at any time. Refer to the most recent edition of the product datasheets at:
http://www.pi-usa.us/products/Air_Bearing_Stages/

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