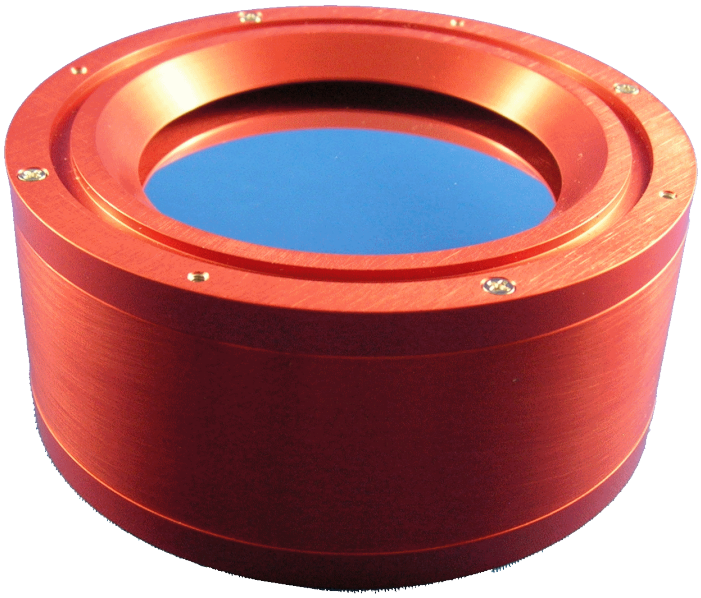
Plate Deformable Mirror Manual



ACTIVE OPTICAL SYSTEMS
2021 Girard Blvd. Suite 150
Albuquerque, NM 87106
(505) 245-9970 x184
www.aos-llc.com

Version 1.1 – 9/17/13

Contents

1 Introduction

Plate deformable mirrors (PDMs) were among the first created during the development of adaptive optics. Figure 1 shows a typical architecture. At AOS, these mirrors are manufactured by bonding an array of lead zirconate titanate (PZT) actuators between a thick baseplate and a thin faceplate. Actuation causes the thin faceplate to distort into predictable shapes called influence functions. Combinations of these influence functions can be used to create a variety of shapes and thereby control the spatial phase of a beam of light.

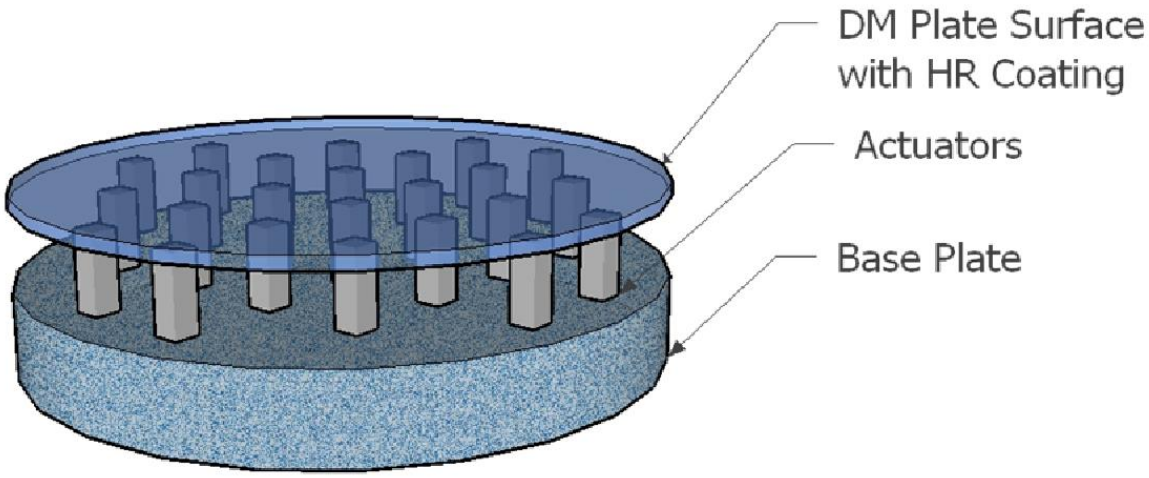


Figure 1 - Plate deformable mirror architecture

2 Plate DM Usage

Plate deformable mirrors have many different uses including:

- Aberration compensation including
  - Atmospheric Aberration Compensation
  - Aero-Optic Aberration Compensation
  - Static or Quasi-Static Optic Aberration Compensation
- Laser beam shaping for
  - Improved gain medium tapping
  - Improved non-linear optics efficiency
- Laser beam clean-up
- Dynamic focus
- Intra-cavity Q-switching
- Temporal pulse shaping

2.1 Warnings

- **Cleaning:** The PDM reflective surface can be cleaned by gently wiping the surface with a lens tissue treated with an approved solvent (isopropanol or water) similar to standard

solvent-based optical cleaning techniques for other high-end optics. Excessive force may scratch the optical surface. For surface dust, a low pressure air system can be used on the front of the faceplate to push the dust from the surface. The surface can be damaged with improper cleaning and may not be able to be repaired.

- **Laser-Induced Damage:** AOS plate deformable mirrors are coated for high reflectivity. Most coatings can be capable of handling high energy laser illumination at proper wavelengths and in proper use conditions (angle of incidence, etc.). Each device and coating varies in its irradiance and power handling limits. AOS is still working to establish these limits, so call AOS to determine limits for any laser use.
- **Static Sensitivity:** The actuators in the PDM are static sensitive. Please use proper grounding techniques when handling the DM.
- **Irreparable Damage Possible:** In some cases, the PDM is not able to be repaired. Damage to the PDM may render it inoperable, so be extremely careful in its use. Please contact AOS with any use questions.
- **Unusual Usage or Disassembly:** To avoid voiding the warranty, please contact AOS before doing anything not outlined as approved usage by AOS. Unapproved usage includes disassembly, use with an unapproved mount, or application of unusual conditions including extreme heat, cold, or vacuum.
- **Inter-Actuator Limits:** To prevent damage, never exceed 2 microns of stroke between adjacent actuators. When setup properly, the AOS software should prevent any inter-actuator limit violations. Make sure that the "spacing" parameter in the DM Controller is set to a value greater than the physical actuator spacing.

3 4" Tube-Type Packaging DMs (2008)

3.1 Optical Setup Tips and Suggestions

Our tube package DMs mount into most standard 4" optics mount, like the U400-AC from Newport Corporation (www.newport.com). For more tips on how to setup a deformable mirror or an adaptive optics system, please consult our application note AN005 on getting started with using AOS hardware.

3.2 Typical Tube-Architecture Deformable Mirror Specifications

Specification	Value
Distance from Mirror Surface to Outer Package Edge	0.3"
Approximate Actuator Capacitance	250 nF
Static Surface Quality	< 1 micron per inch of diameter.
Standard Number of Actuators	37, 42, 95 (custom actuator patterns available)
Minimum Actuator Spacing	6 mm
First Resonance Frequency	~3 kHz

3.3 Common Actuator Patterns

We have manufactured the three different actuator patterns shown in Figure 2, but can easily make custom designs.

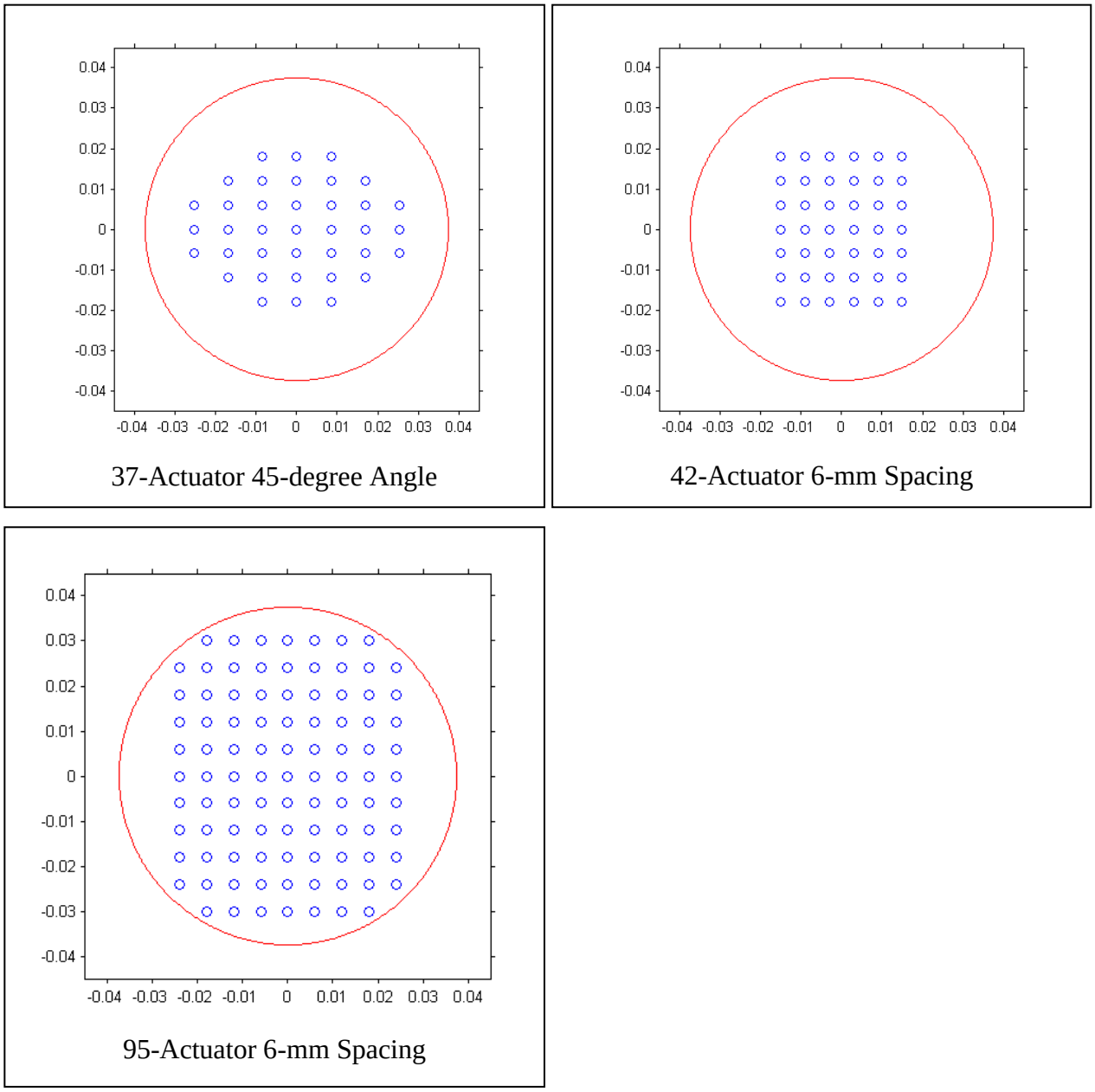
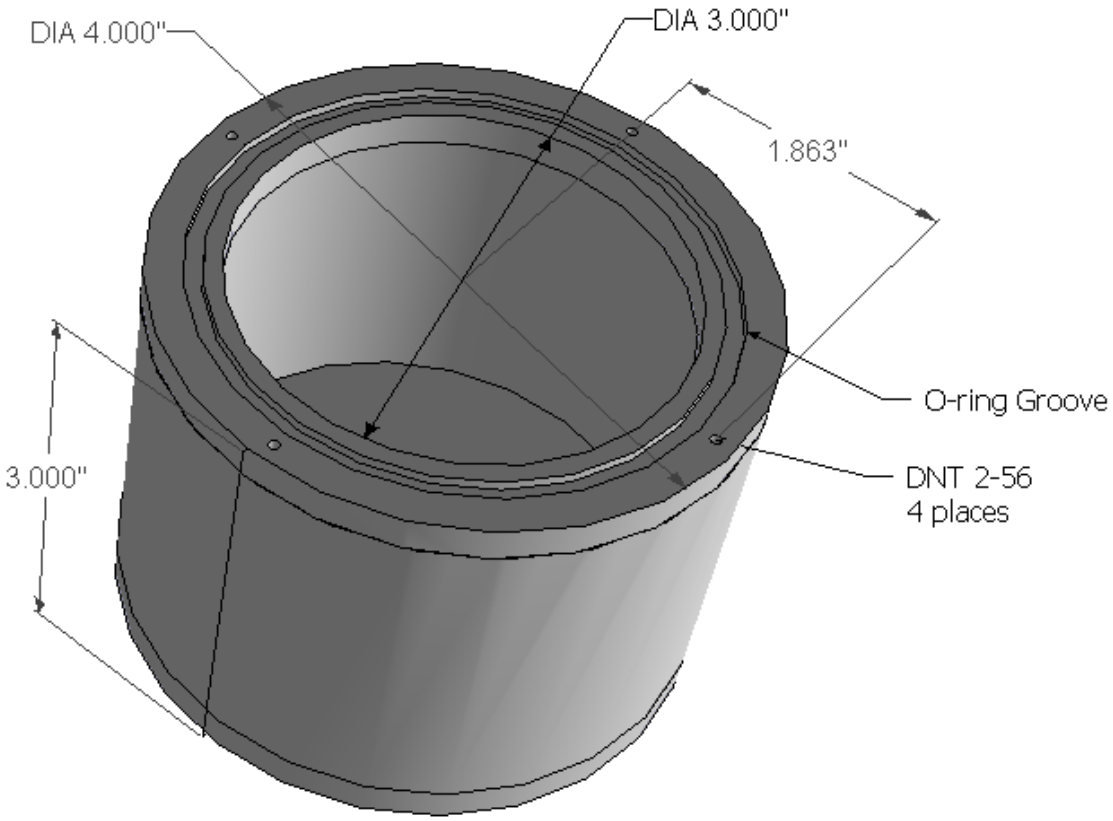


Figure 2 - DM actuator patterns for three commonly-used plate-type DMs designed for a 4" tube-package

3.4 Plate DM Package

We manufacture some standard PDMs, but can make virtually anything a customer wants. Our standard PDMs are all packaged in the following package or minor variants of this:



4 5” Box-Type DM Package

Around 2011, we began using a box-type package for mounting plate-type DMs manufactured from a 5” square aluminum tube extrusion. Figure 3 shows a 3D CAD rendering of the package from the front and back. The hole indicated in the back surface is where a kinematic mount screw enters the package and enables tilt alignment of the DM.

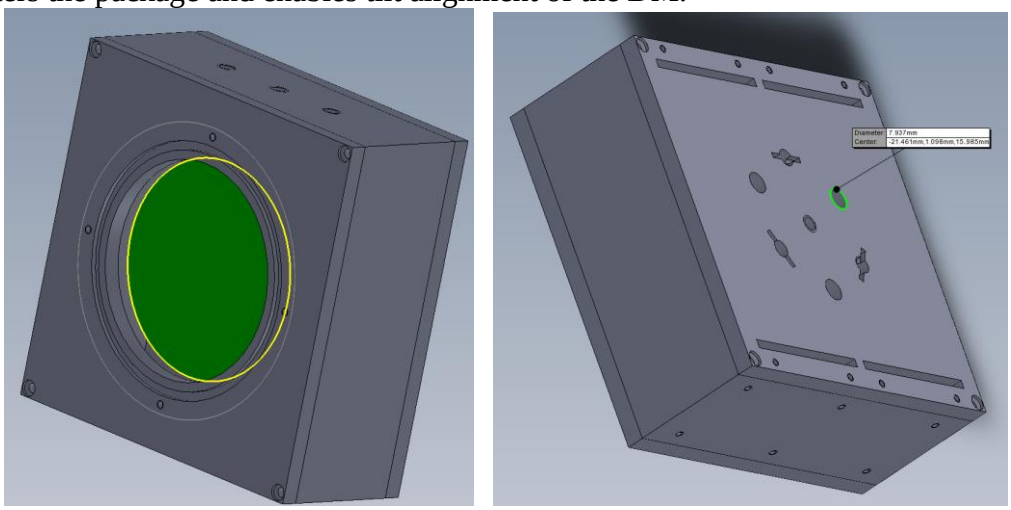
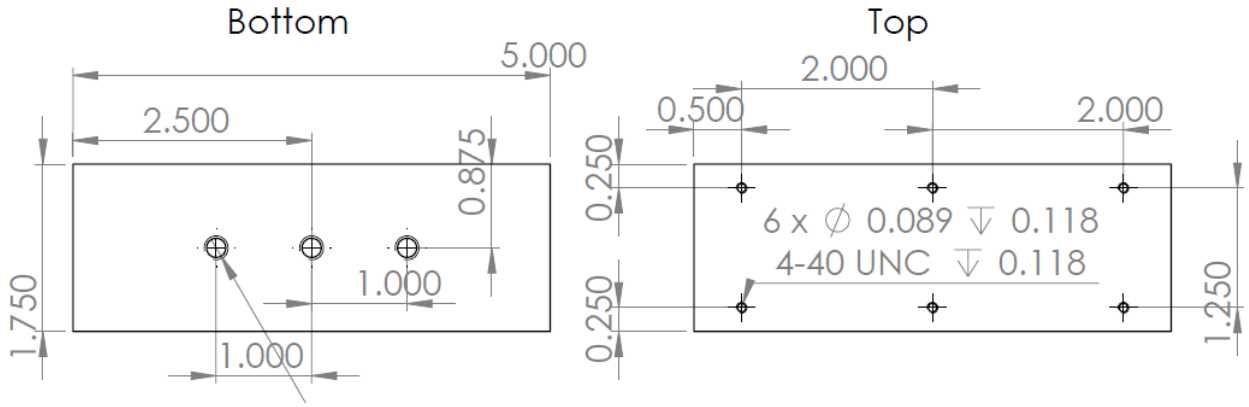


Figure 3 - 3D CAD Rendering of the 5" box DM Package

4.1 Mounting Holes

Below is a mechanical drawing of the top and bottom surfaces of the 5” plate-type DM package with the mounting holes. The bottom surface with ¼-20 holes are designed to be mounted to directly using standard optics mounts. The 4-40 holes in the other surface are designed to be used for an adapter plate so that the user can make any mounting surface they need and attach it to the DM package. One advantage of using a custom plate to mount the DM is that any error in rotation of the actuators relative to the mounting surface can be accommodated using shim stock between the package surface and the mounting plate or can be accommodated using an additional kinematic mounting stage. The mounting holes are all blind tapped to prevent dust from entering the package and to prevent mounting screws from entering the package and doing damage to the DM.



4.2 Internal Kinematic Stage

The 5" box package can accommodate an optional internal kinematic stage. Figure 4 shows a photograph of the back surface of a 5" box package with the three kinematic adjustment thumb screws and the internal spring attachment points. The central ¼-20 set screw is designed to prevent the user from retracting the kinematic screws too far and causing loss of tension on the springs. It should not be possible with the current design, but the user should be careful to not overextend the kinematic screws and cause the DM surface to contact the package.

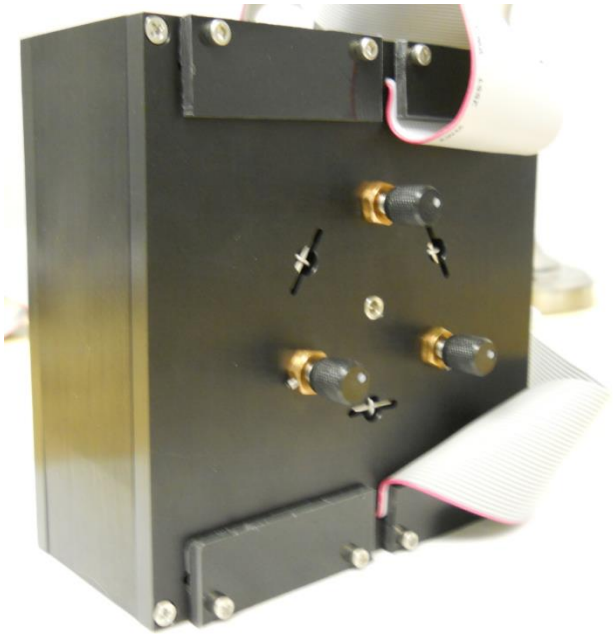


Figure 4 - Back DM package surface with optional kinematic stage

4.3 Actuator Patterns

Figure 5 shows the two different actuator patterns we have manufactured using the 5" box package.

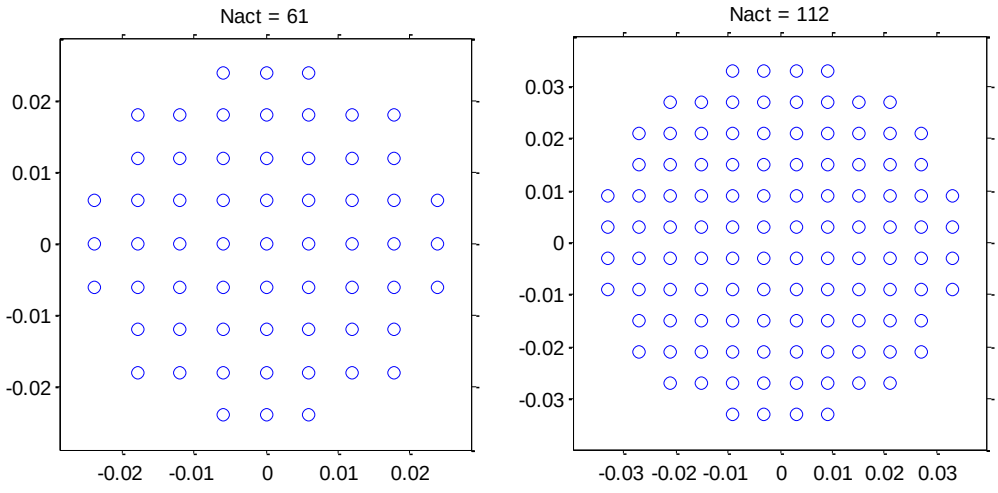


Figure 5 - Actuator Patterns of two DMs compatible with the 5" Box Package

5 Wiring

The wiring of actuators to the electrical connectors is captured inside the .DM file for each of the AOS plate-type DM devices. If the pin-to-actuator mapping is needed for a DM, please contact AOS.

6 Custom Packages

We have manufactured other DMs using custom packages for customers. For more information on other packages we have manufactured, please contact AOS directly.