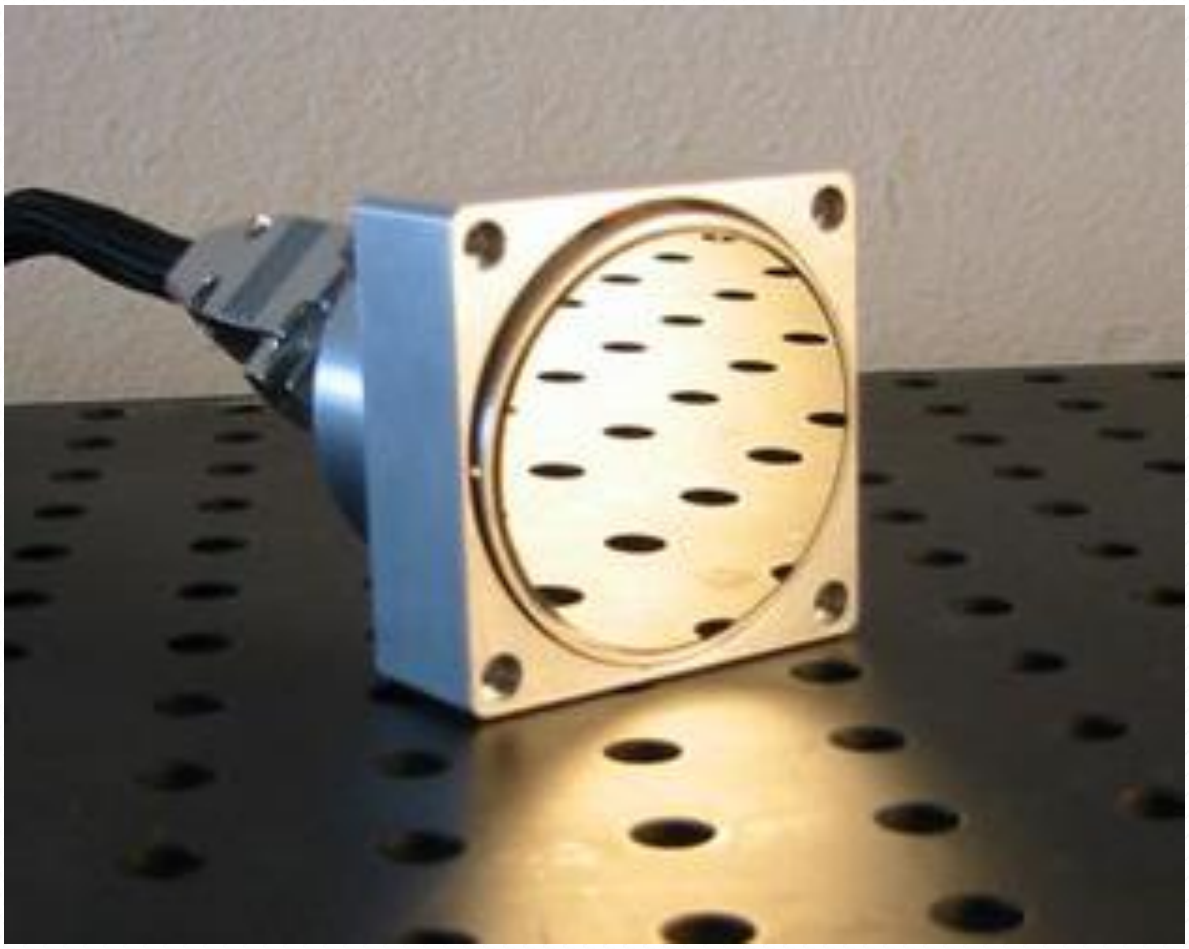
Fast Steering Mirror



User's Manual

OIM100 series FSM

Models OIM101, OIM102, OIM102.3

Optics In Motion

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Revision D

Product Warranty

Optics-In-Motion LLC warrants this product to be free from defects in material and workmanship for a period of 1 year from the date of shipment. If the product is found to be defective during the warranty period, the product will either be repaired or replaced at Optics-In-Motion's option.

This warranty does not apply to defects resulting from modifications or misuse of any product or part.

Optics-In-Motion LLC shall not be held liable for any indirect, special, or consequential damages caused by the use of the product.

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Fast Steering Mirror Description

Voice coil driven Fast Steering Mirrors (FSM) have been used for several years in military and aerospace applications for target acquisition, scanning, and beam steering. These mirrors were typically low volume – high cost parts. Optics-In-Motion has engineered a line of fast steering mirrors which have many of the attributes of the military versions (low noise, high pointing accuracy, and high acceleration/step speeds) but are available at commercial prices.

Fast Steering Mirror Models:

The 100 series fast steering mirror product line consists of a one inch glass version with a user replaceable mirror/sub-mount, and a two inch glass mirror version where the mirror is hard mounted to the mirror gimbal, and a 2.1" x 3" elliptical version.

Model OIM101 Mirror key features:

- ✓ Uses industry standard 1" x 0.25" (or 1" x 6mm) glass mirrors
- ✓ Mirror coating to customer requirements
- ✓ Mirror mounted into sub-mount using low out-gassing RTV
- ✓ Additional sub-mount available for user installation of mirror
- ✓ Wave-front quality 1/10th wave p-v (depends on mirror substrate)
- ✓ Useable aperture 0.94"

Model OIM102 Mirror key features:

- ✓ 2" glass mirror mounted to gimbal using low out-gassing RTV
- ✓ Mirror coating to customer requirements
- ✓ Wave-front quality ¼ wave rms
- ✓ Useable aperture 1.95"

Model OIM102.3 Mirror key features:

- ✓ 2.1" x 3" glass mirror mounted to gimbal using low out-gassing RTV
- ✓ Mirror coating to customer requirements
- ✓ Wave-front quality ¼ wave rms
- ✓ Useable aperture 1.95" viewed @ 45 degrees incident angle

Drive Motors:

All mirror models are driven by a push/pull configuration of voice coils (similar to speaker coil – magnet arrangement). However unlike a speaker the FSM is configured with a moving magnet instead of a moving coil. This arrangement has several advantages. The first being that since the coil is stationary the wires do not have to move which adds greater overall reliability. The second advantage is that the heat generated by the mirror coils is conducted to the mirror housing away from the optical mirror substrate. This prevents thermal distortions of the mirror wavefront quality. Proper heatsinking of the coils prevent coil damage when the mirror is overdriven.

Mirror Suspension:

The mirror is flexurally suspended in two axes. The flexure is designed for an infinite fatigue life under normal operation (the absence of high levels of external vibration). The mirror rotates in both directions around a single pivot point. The pivot point for model OIM101 (1" mirror) is located 12mm behind the mirror surface and for model OIM102 (2" mirror) the pivot point is 9.5mm behind the mirror surface. The OIM102.3 has a pivot point located 12.5mm behind the mirror surface.

Mirror Angular Position:

Local Position – the mirror has a built in optical position sensor. The position sensor provides mirror feedback information to the controller which can also be monitored by the user. The local position sensor outputs a voltage which is proportional to the mirror angular position. The position sensor scale factor is 10volts = 1.5 degrees (26.2 mrad) and has a range from +10 volts (+1.5 degrees mechanical +3.0 degrees optical) to -10 volts (-1.5 degrees mechanical, -3.0 degrees optical).

External Position – the mirror controller has inputs for a user supplied control signals. Typically these signals are from an external quadrant cell which is used to monitor the position of a beam reflected off the surface of the fast steering mirror. These external signals (x and y position angles) are differentially input into the mirror command connector. A TTL level high input to the command connector INT/EXT switch controls the source of mirror feedback, switching it from local to external position control. In normal operation (internal feedback mode) these connections are left open.

Mirror Controller:

The mirror controller electronics are housed in a remote enclosure connected to the FSM via a 6 foot cable. Mirror commands are input to the controller through a 25 socket D sub-miniature connector. The commands are differential signals representing the x and y mirror positions, scaled to the +/- 10 volt range. For example, the X- command can be grounded and the X+ command can go from +10volts to -10volts. The input impedance of the command signals is 10K ohms. Monitor signals are provided for the actual mirror positions, error signals (feedback error between commanded position and actual position). The PID gain of the controller may be set from the controller front panel potentiometers (See fig. 1)

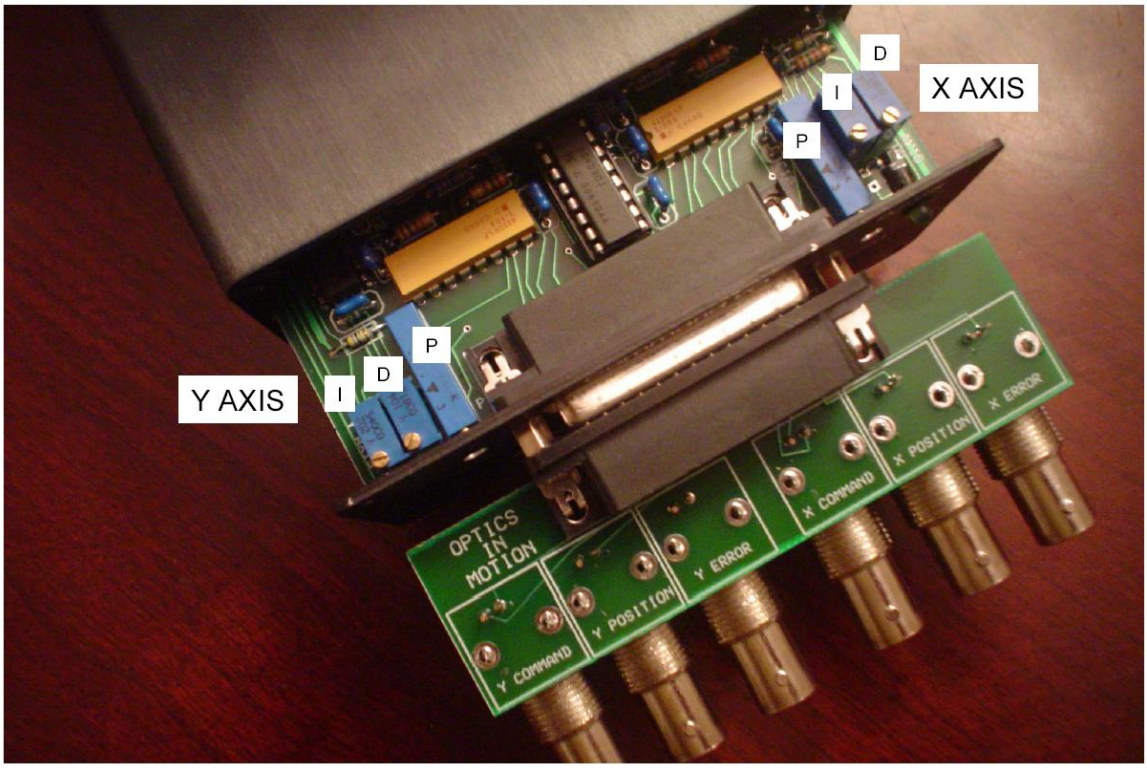

Figure 1: Adjustable PID

The potentiometers that are accessible from the controller front panel set the mirror proportional gain (P), CCW is increasing gain. The other adjustment potentiometers are mounted to the controller board, to access these pots the front 4 cover screws must be removed. The photo in figure 1 shows the front panel slid forward to allow access to the integral (I) and derivative (D) gain potentiometers (CCW to increase gain on both these pots). The controller card is attached to another card via a ribbon cable which is hidden inside the controller box. The mirror can be driven while this card is pulled forward, allowing the user to optimize the PID values for a given step requirement while

monitoring the position and error signals on a scope. Also shown in the figure is our 25 pin D to BNC adapter that can be used for non OEM operation.

Mirror Power Supply:

The controller is powered by an external +/-15 volt power supply capable of 1.5 amps of current. The external power supply is an air cooled tabletop supply which plug directly into a 110 or 220 volt wall socket.

Figure 2: Controller Front View

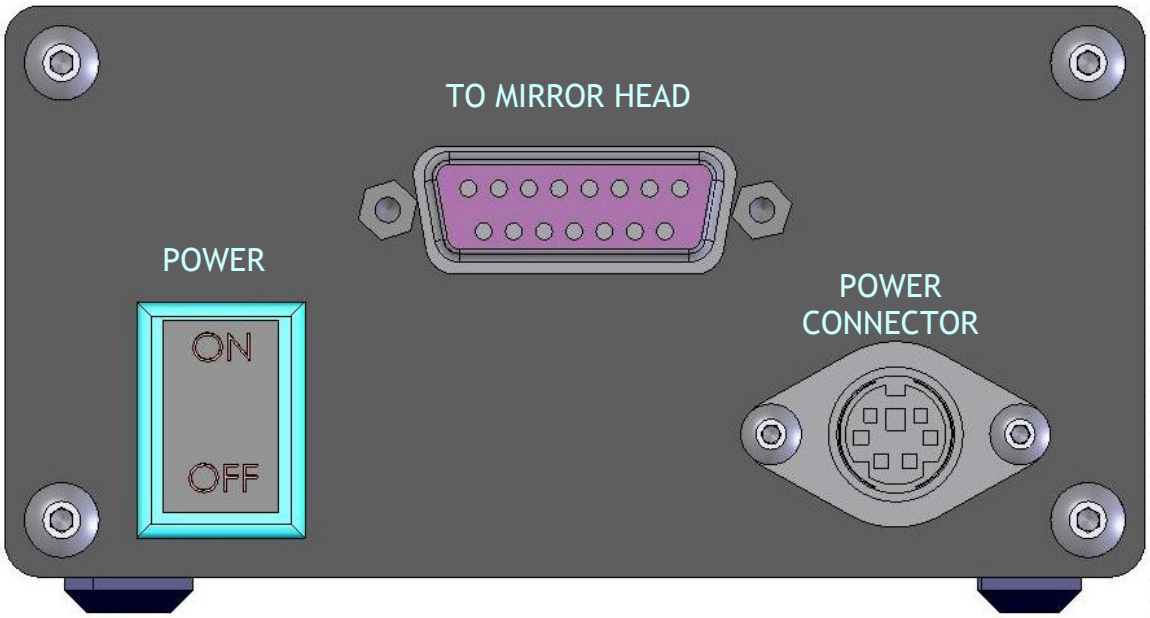

Figure 3: Controller Rear View

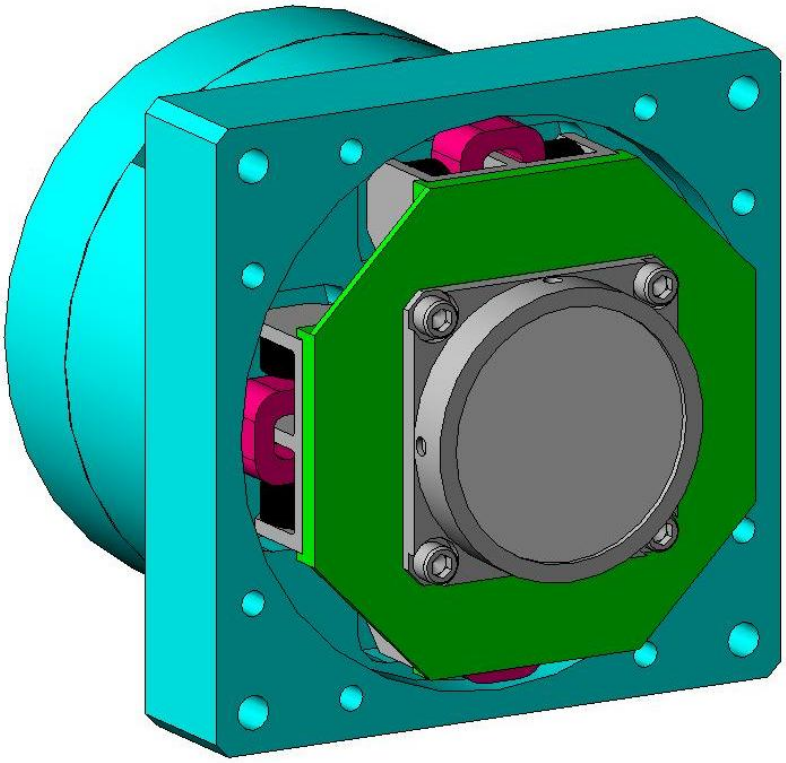

Figure 4: Model OIM101 Mirror Head Front View

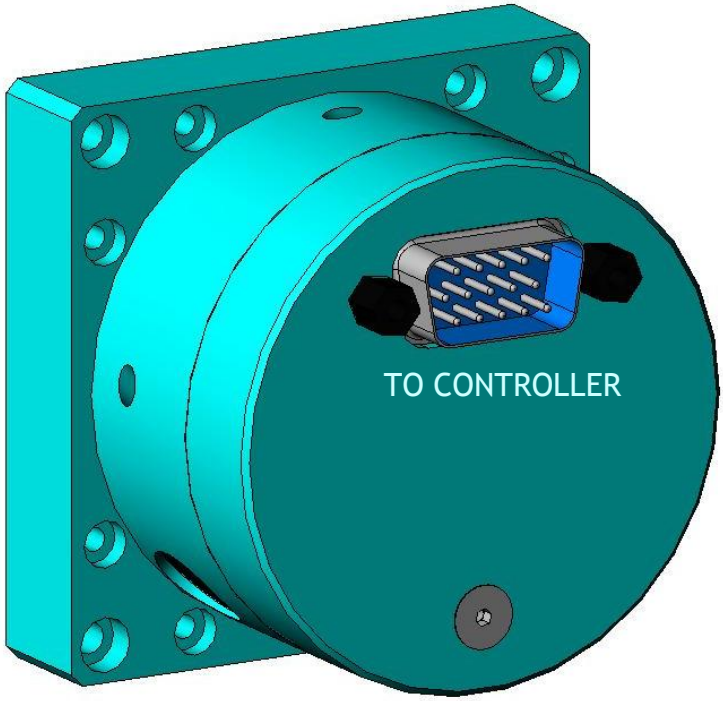

Figure 5: Model OIM101 Mirror Head Rear View

Command Connector Wiring Table

25-Socket Sub-miniature D Connector

Pin Number	Signal Name	I/O Type	Description
1	X ERROR	Output	X summing junction error voltage output, difference between commanded and actual position. (referenced to ground)
2	INT/EXT SWITCH	Input	Normally low TTL input. High level switches the position feedback input from local to external. (used with input pins 10,11 and 17, 5)
3	X- COMMAND	Input	X mirror position command. Low side of differential command input. Range +/-10 Volts.
4	X+ COMMAND	Input	X mirror position command. High side of differential command input. Range +/-10 Volts.
5	X- EXTERNAL	Input	X external mirror position. Low side of differential position input (from external quad or similar position sensor)
6	GND	Output	Ground Reference
7	-15 VOLTS	Output	-15 VDC for external loads of less than 100ma.
8	RESERVED		
9	N/C		
10	Y+ EXTERNAL	Input	Y external mirror position. High side of differential position input (from external quad or similar position sensor)
11	Y- EXTERNAL	Input	Y external mirror position. Low side of differential position input (from external quad or similar position sensor)
12	Y- COMMAND	Input	Y mirror position command. Low side of differential command input. Range +/-10 Volts.
13	Y+ COMMAND	Input	Y mirror position command. High side of differential command input. Range +/-10 Volts.
14	X POSITION	Output	X mirror angular position readout from local position sensor. (referenced to ground)
15	+5 VOLTS	Output	5 VDC for external loads of less than 100ma.
16	GND	Output	Ground Reference
17	X+ EXTERNAL	Input	X external mirror position Low side of differential position input (from external quad or similar position sensor)
18	RESERVED		
19	+15 VOLTS	Output	+15 VDC for external loads of less than 100ma.
20	GND	Output	Ground Reference
21	RESERVED		
22	GND	Output	Ground Reference
23	Y POSITION	Output	Y mirror angular position readout from local position sensor. (referenced to ground)
24	Y ERROR	Output	Y summing junction error voltage output, difference between commanded and actual position. (referenced to ground)
25	RESERVED		

Fast Steering Mirror Block Diagram

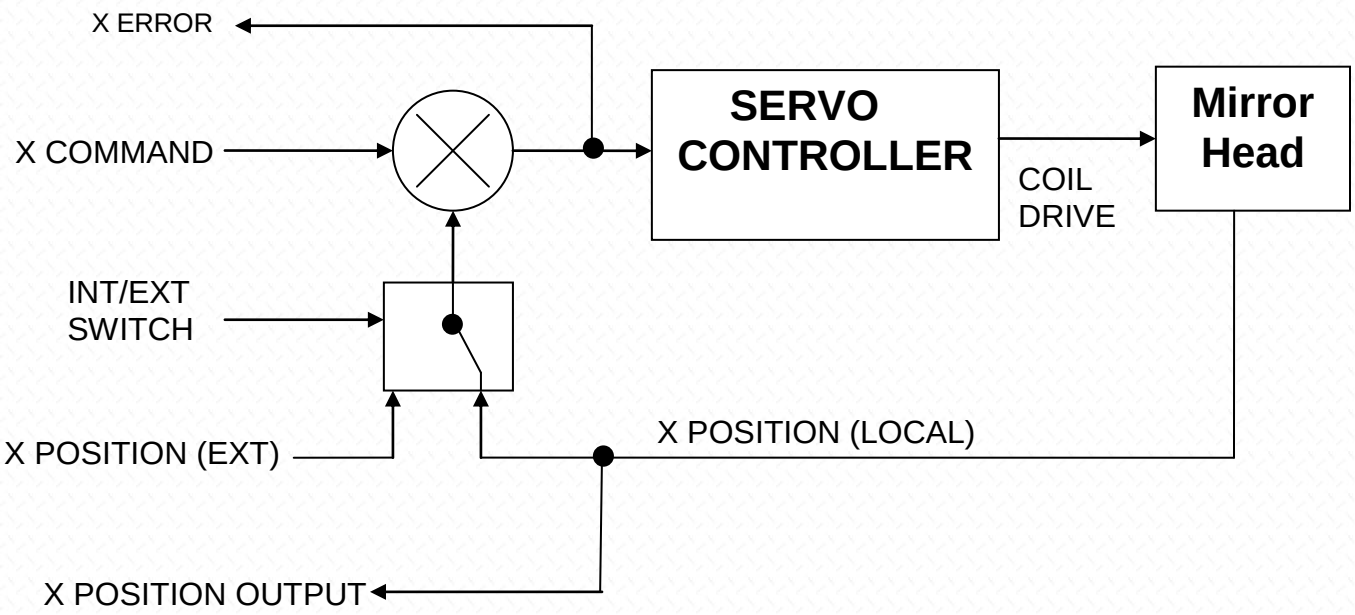

Figure 6: Block diagram for X-axis control