Flexible Optical B.V.
Adaptive Optics • Optical Microsystems • Wavefront Sensors

30 mm 79-channel micromachined deformable mirror system:

technical passport

OKO Technologies,

OKO Technologies is the trade name of Flexible Optical BV

1 Membrane mirrors

Silicon micromachined mirror is fabricated by Flexible Optical B.V. using the technology of silicon bulk micromachining.

The mirror, shown in Fig. 1, consists of a silicon chip mounted over concentric electrostatic electrode structure. The chip contains multilayer silicon nitride membrane, which is coated with a special coating to form the mirror. The PCB contains the control electrode structure, spacer and connector. The initial shape of the reflective membrane can be adjusted using 8 adjustment micrometric screws on the back side of the mirror mount.

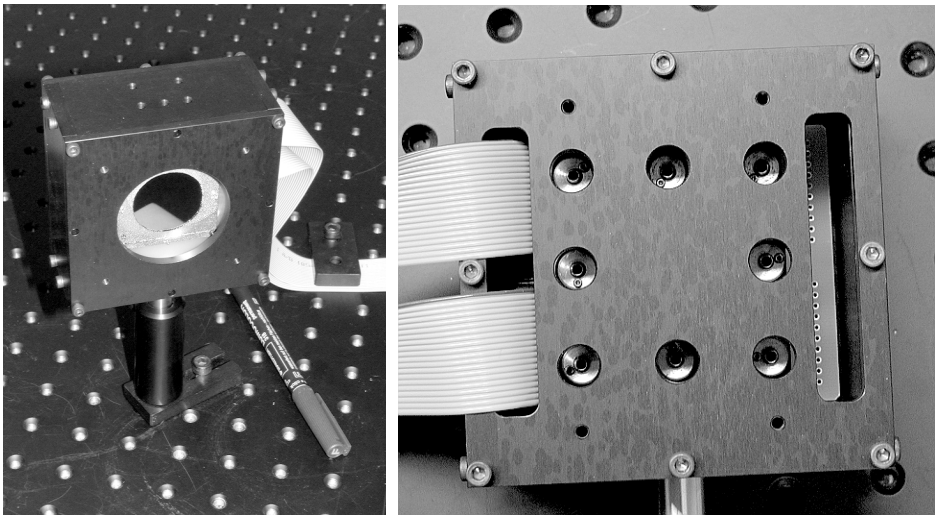

Figure 1: *Front and back view of the mirror.*

The device can be used for fast dynamic correction of low-order optical aberrations such as defocus, astigmatism, coma, etc in lasers, telescopes, ophthalmology, displays and general imaging optics.

The scheme of the assembled mirror and the principle of biased control are illustrated in Fig. 2

See Table 1 for the technical parameters of the mirror.

A number of surface and coating defects with total area not exceeding 2mm^2 can be present on the mirror surface. These defects do not influence the quality of the mirror.

2 Actuator structure

The membrane is mounted over the printed actuator structure (20mm in diameter for 39-ch mirror and 30mm in diameter for a 59- and 79-ch mirror) shown in Fig. 3.

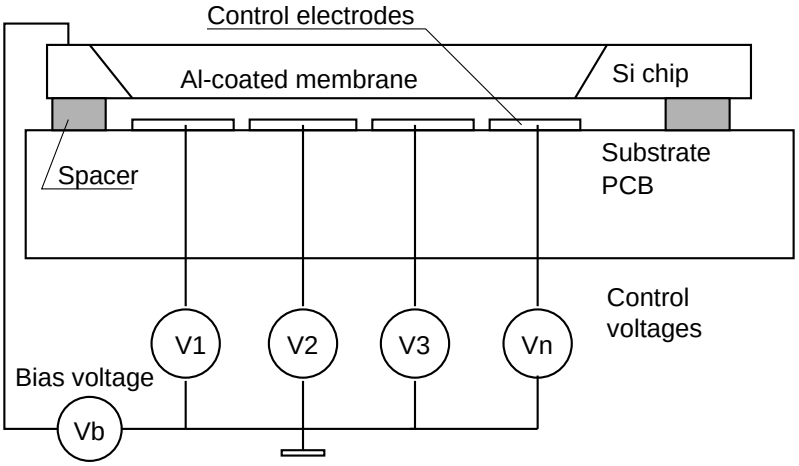

Figure 2: *Schematic section of the micromachined adaptive mirror.*

Table 1: *Technical parameters of 30mm 79-channel MMD mirror.*

Parameter	Value
Aperture shape	approximately circular
Aperture dimensions	30mm diameter
Mirror coating	Al
Number of electrodes	79 (see Fig. 3)
Control voltages V_c	0 . . . 304 V
Initial RMS deviation from reference sphere	less than 0.06 μm
Main initial aberration	1 fringe(s) at 532nm
Frequency range	not specified
Maximum deflection of the mirror center	12 μm
Surface defects	up to 2 coating defects
Mirror serial number	Typical MMDM30-79
Shipped with	USB DAC # D40V2xxx and D40V2xxx

3 Control amplifier unit

The mirror is controlled by one or two high-voltage amplifier unit. To use the unit, you must connect it to the mirror, to a DAC USB unit (or PCI boards) and to the wall outlet (85 to 250V AC, 50 to 60 Hz). Connect the mirror with a supplied flat ribbon cables to the 20-pin connectors on the front side, and the driver boards or the USB unit to the 26-pin connectors. For 59- and 79-channel mirrors, connect together the ground sockets located on the back panels of the units.

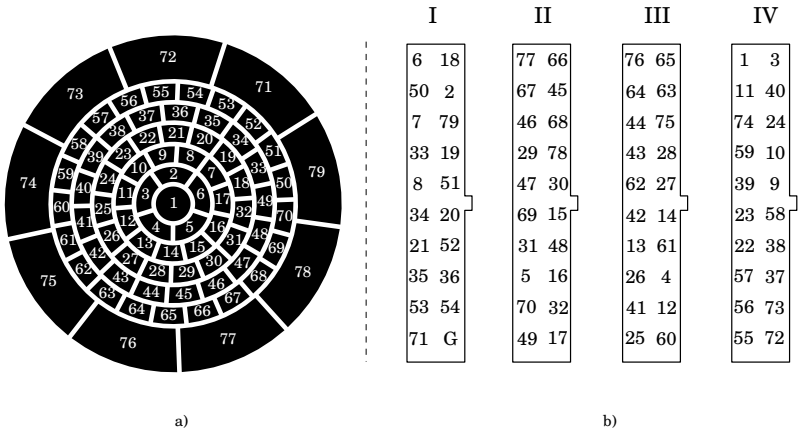

Figure 3: *The PCB actuator structure and pinout, top (mirror surface) view for 79-channel mirrors.*

Figure 4: *40 channel high-voltage amplifier unit.*

4 DAC Unit

A single "DAC-40-USB" unit can control up to 40 channels. Please see the separate unit description for detailed installation guide.

The pinout of the DAC unit and the pinouts of the board cable and the cable coming from the high voltage board are shown in Fig. 6. The DAC unit connector

Figure 5: *Front and back panels of 40 channel high-voltage amplifier unit.*

pinout is given for one of its male connectors. The cable pinouts are given for the cable female connectors viewed from the front side.

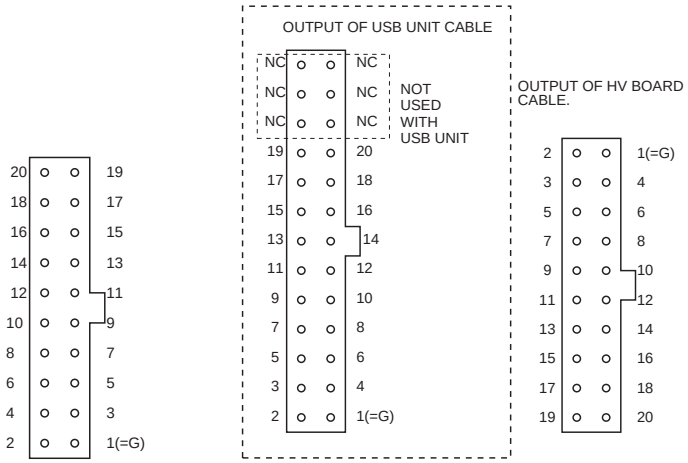

Figure 6: *Pinouts of the first connector of the "DAC-40-USB" unit and cables. The numbers correspond to the numeration of "DAC-40-USB" output channels. Second connector is connected in a similar way.*

For 59- and 79-channel mirrors, connect together the ground sockets located on the back panels of the units.

5 Optical quality

The mirror was tested interferometrically before shipping. The interferometric patterns are shown in Fig. 7.

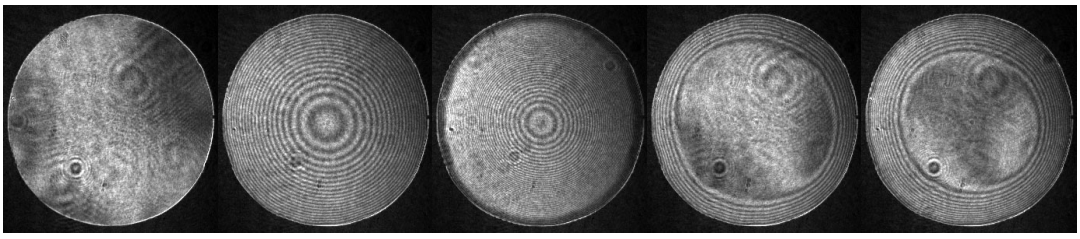

Figure 7: *The initial optical figure of the mirror, bias voltage applied to all actuators; maximum voltage applied to all actuators, to edge external ring of actuators (alignment actuators) and to two external rings of actuators. Maximum deflection of the order of 45 fringes with all actuators on at maximum voltage. Interferograms recorded at 532nm wavelength.*

See also files `"initial*.png"` in the root directory and/or Appendix to this passport for the report on initial shape of the mirror.

6 First run of the system

- **Read this document through before performing any practical steps**. Follow the instructions exactly, if it's written `connect the board, connect the mirror` — **first** connect the board and **then** connect the mirror.

- All following operations refer to:

  – either *DAC-40-USB unit/Ethernet DAC-40* connected to a computer running Windows - we used XP SP2 for final tests

  – or *digital boards* installed in a computer running Linux - we used RH 7.2 for final tests.

- *For DAC-40-USB unit.* Connect the DAC USB unit to the computer USB port. Install the software (refer to the DAC USB unit guide). Jumpers of the USB unit are already preset to the correct position (first connector provides 19-channel output and ground, other connectors provide 20 output channels each). Run the example programs supplied with the CD to test the DAC USB unit functionality.

- Switch the amplifier unit off. Remove the shorting links from the mirror cables (keep them to use in cases you need to move/ship the mirror). Connect the amplifier unit to the DAC USB unit and to the mirror. At this stage the system is fully assembled but the adaptive mirror is not used yet. Switch on the amplifier unit. If the DAC unit LED goes off, disconnect the DAC unit from PC and reconnect it again. Run the test programs. Control all channels. When not using the mirror, switch off the the amplifier unit.

- You may start to use the mirror if all channels work. Use "am_set" and "rotate" as templates to write your own control programs.

7 Remarks

The maximum voltage for the mirror is 304 V.

The amplifier unit is already tuned to the output voltage 304 V, **do not use an amplifier unit shipped with another mirror!**

Do not plug any pins into vias on the back side of the mirror. Do not allow for any air pressure difference between the front and back sides of the device. Do not touch the printed structure at the back side of the mirror.

The jumpers on the amplifier board are configured to ground the membrane.

Do not touch or clean the membrane. Never think about touching or cleaning the membrane.

7.1 Mirror realignment

In the first days of operation, the mirror figure can drift due to relaxation of internal stresses. The mirror can be re-aligned.

OKO Technologies is not responsible for the result of alignment procedure and provides no warranty!

To align:

1. remove the cable bracket and put the cable aside (do not disconnect). Connect the mirror to the control board.

2. put the mirror into interferometer and fix it solidly.

3. Using 0.9mm hex key release the screw latches (see Fig. 1).

4. Set all actuator voltages to zero and align the mirror to observe zero interferometric pattern.

5. By slight clockwise turns of alignment screws adjust the mirror figure. Do not turn the screws more than 10 degrees of arc counterclockwise! By doing that you may land the membrane onto the actuator structure and destroy the mirror. Use hex key with a very long handle to improve the sensitivity of alignment. In general you will need extremely gentle movement (about one degree of arc) of the screws. Be careful - the screws can be quite tight.

6. Apply maximum voltage to all actuators and check whether the deformation is symmetrical with respect to the mirror center. If not - realign the membrane to make it parallel to the actuator structure.

7. Repeat 5...6 until satisfaction is reached.

8. Fix the screw latches.

8 Warranty

The equipment is covered by a one-year factory-defect warranty.

If the mirror is damaged during shipping, it will be replaced by a similar device within two months. A photo of the damaged device should be sent to Flexible Optical B.V. (OKO Technologies) within 3 days after the damaged device is received.

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9 Contact person

All questions about the technology, quality and applications of adaptive mirror should be addressed to:
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The Netherlands

Date:

Signature:

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