

Flexible Optical B.V.



Adaptive Optics • Optical Microsystems • Wavefront Sensors

# 19- channel piezoelectric deformable mirror system technical passport

OKO Technologies,

OKO Technologies is the trade name of Flexible Optical BV

## 1 Technical data

The mirror, shown in Fig. 1, consists of 19 piezoelectric column actuators bonded to the base holder. Reflective plate is bonded to the top of the actuator structure and coated to form the mirror. The shape of the faceplate is controlled by the voltages applied to the actuators.

**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.**

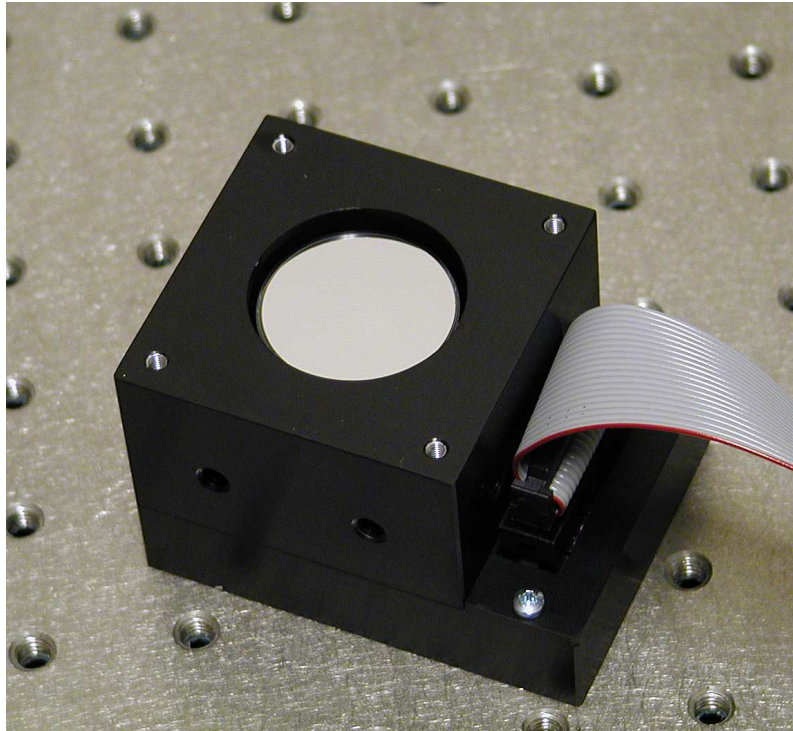


Figure 1: Typical view of a 19-ch piezoelectric deformable mirror. Please note that these mirrors can be fabricated with different package designs, so the mirror you have may look differently.

The mirror can be supplied with initially slightly curved spherical surface. This sphericity is caused by the stress in the mirror coating. It does not influence the parameters of the mirror, but should be taken into account when the mirror is incorporated into the optical setup.

Due to hysteresis of actuators, the initial aberration may change during the mirror usage and deviate more from the reference sphere. This deviation is a superposition of actuator response functions and is irrelevant in active setups with closed-loop control, though it may slightly reduce the correction range.

## 2 Control amplifier unit

The mirror is controlled by a 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.

Table 1: Technical parameters of the mirror.

Parameter	Value
Aperture shape	circular 30 mm in diameter
Mirror coating	Al (LC# 3007921)
Actuator voltages	0.. + 400V (with respect to the ground electrode)
Recommended maximum voltage	300V
Number of electrodes	19(see Fig. 2)
Actuator capacitance $C_a$	5 nF
Initial RMS deviation from reference sphere	
in 30-mm aperture	less than 0.08 $\mu\text{m}$
in 20-mm aperture	less than 0.04 $\mu\text{m}$
Main initial aberration	concave sphere with $R \sim 70$ m
Maximum stroke	8 $\mu\text{m}$ at +400V 6 $\mu\text{m}$ at +300V
Number of actuators	19
Internal actuator ring	$\varnothing 23$ mm
External actuator ring	$\varnothing 28$ mm
Mirror serial number	13.21
Shipped with	USB DAC # D40V2d75

The HV unit supplied with your mirror is tuned to secure safe operation of the mirror.

### 3 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. 5. The DAC unit connector pinout is given for one of its male connectors. The cable pinouts are given for the cable female connectors viewed from the front side.

### 4 Optical quality

The interferograms of the mirror obtained before shipping are shown in Fig. 6. The interferograms were registered at wavelength  $\lambda = 532$  nm.

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

### 5 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**

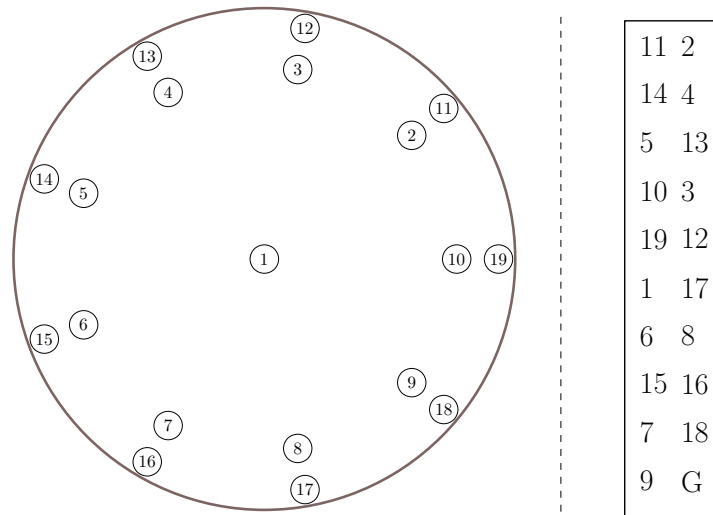


Figure 2: The connector pinout and the geometry of mirror actuators for the 19-ch mirror, view from the mirror side.



Figure 3: 40 channel high-voltage amplifier unit.

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 or Windows - we used Windows XP SP2 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.



Figure 4: Front and back panels of 40 channel high-voltage amplifier unit.

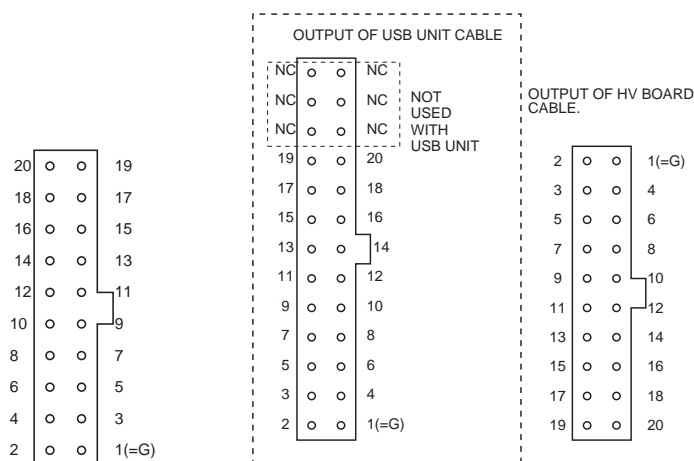


Figure 5: Pinouts of the first connector of the "DAC-40-USB" unit and cables. The numbers correspond to the numeration of "DAC-40-USB" output channels. Second connector is connected in a similar way.

- 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.

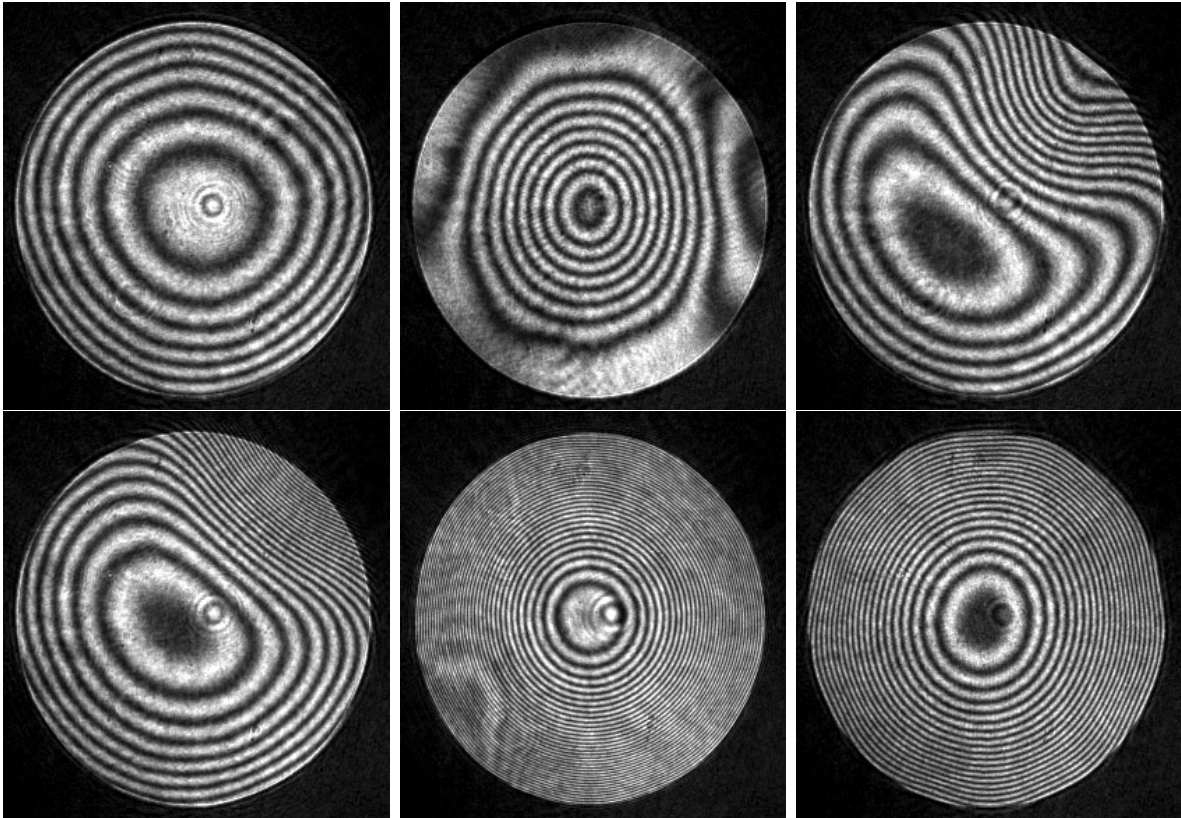


Figure 6: Test of the mirror: zero voltage applied; 300V applied to: the central actuator, an actuator from the internal ring, an actuator from the outer ring, to all actuators from the outer ring, to all actuators from the inner ring and the central actuator (top to bottom, left to right).

## 6 Remarks

The jumpers on the amplifier board or in the amplifier unit, in the DAC control unit are preset before shipping; this configuration should not be changed. **The system and jumper configuration were tested before shipping.**

**Do not touch or clean the mirror. We are not responsible for any damage to the mirror due to a cleaning attempt. If you need to clean the mirror, please contact us; we can clean it for you.**

## 7 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.

EXCEPT WHEN OTHERWISE STATED IN WRITING FLEXIBLE OPTICAL B.V. (OKO TECHNOLOGIES) AND/OR OTHER PARTIES PROVIDE THE SYSTEM "AS IS" WITHOUT WARRANTY OF ANY MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE EQUIPMENT IS WITH YOU.

IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL FLEXIBLE OPTICAL B.V. (OKO TECHNOLOGIES) BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE EQUIPMENT DESCRIBED IN THIS DOCUMENT.

## 8 Contact person

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

Flexible Optical B.V.  
Polakweg 10-11,  
2288 GG Rijswijk  
The Netherlands

Date:

Signature:

(Dr. Oleg Soloviev,  
Senior Associate)