Flexible Optical B.V.

Adaptive Optics • Optical Microsystems • Wavefront Sensors

109-channel 50mm 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 109 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.

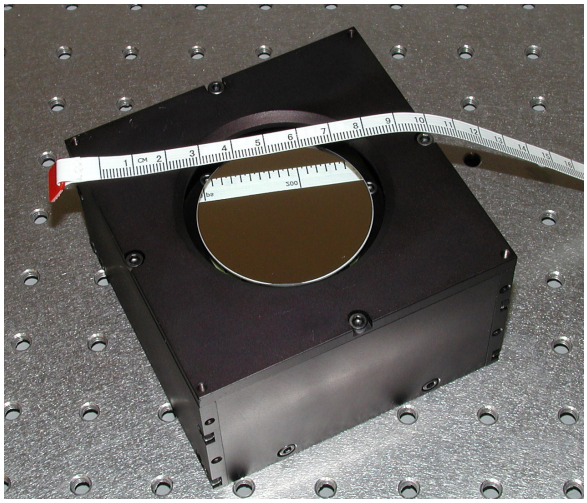

Figure 1: Typical front back view of a 109-ch 50mm piezoelectric deformable mirror. Please note that these mirrors can be fabricated with different package designs, so the mirror you have may look differently.

Table 1: Technical parameters of the mirror.

Parameter	Value
Aperture shape	circular 50mm in diameter
Mirror coating	Al
Actuator voltages	$0 + 400$V (with respect to the ground electrode)
Number of electrodes	109 (see Fig. 2)
Actuator capacitance C_a	$\sim$ 5nF
Initial RMS deviation from reference sphere	less than 2 μm
Main initial aberration	sphere with R$\sim$ 100m
Maximum stroke	8μm at $+400V$
Actuator pitch	4.3mm

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.

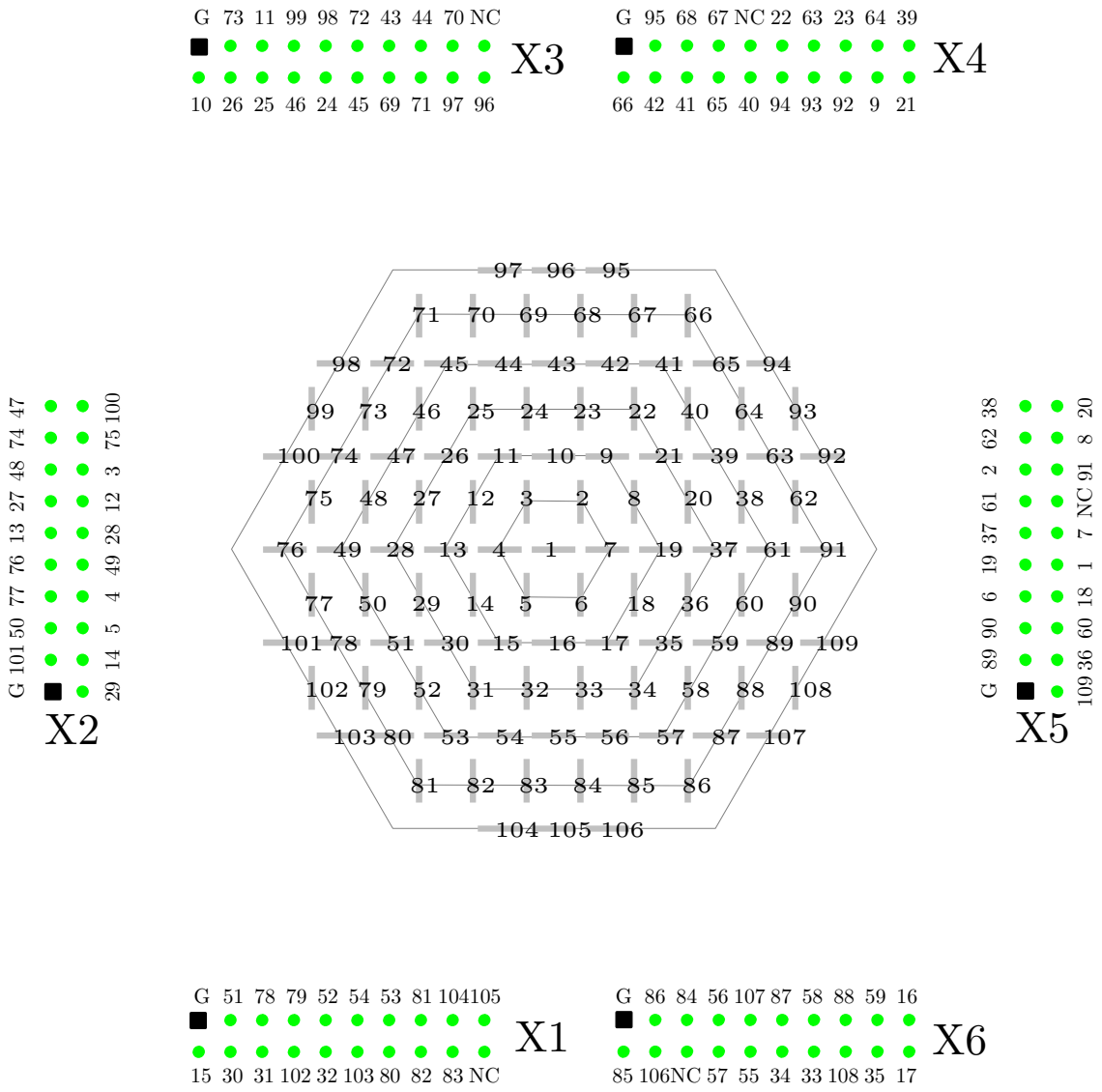

Figure 2: The geometry of mirror actuators and its correspondence to the mirror connectors pinout (view from the mirror side)

2 Control amplifier unit

The mirror is controlled by three high-voltage amplifier unit. To use the units, you must connect them to the mirror, to DAC USB units (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.

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

In case of OEM version of the system, the mirror is controlled by two high-voltage amplifier boards. Each board contains 20 non-inverting DC amplifiers with gain 35, 59, or 79 depending on the board type, and should be connected to a high-voltage (< 400V) power supply and to a stabilized ± 15V DC supply. Connect the ground, +15V and -15V to the pins marked G,+ and –. Connect positive high-voltage stabilized DC supply to the pin marked V_high, connect negative high voltage terminal to the ground (see Fig. 5). **The high voltage supply should**

Figure 3: 40 channel high-voltage amplifier unit.

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

not exceed 400 V DC. Use the flat ribbon cable supplied to connect the driver board to the mirror socket.

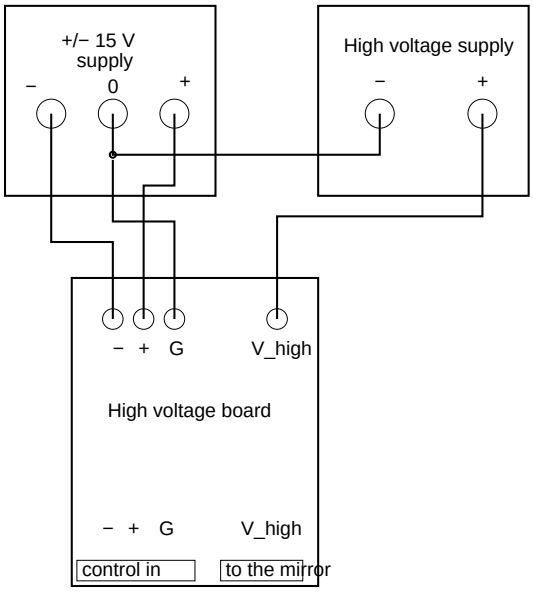

Figure 5: Power supply wiring for OEM version of the system. Position of the connectors can be different; refer to the board manual and/or marking on the board.

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.

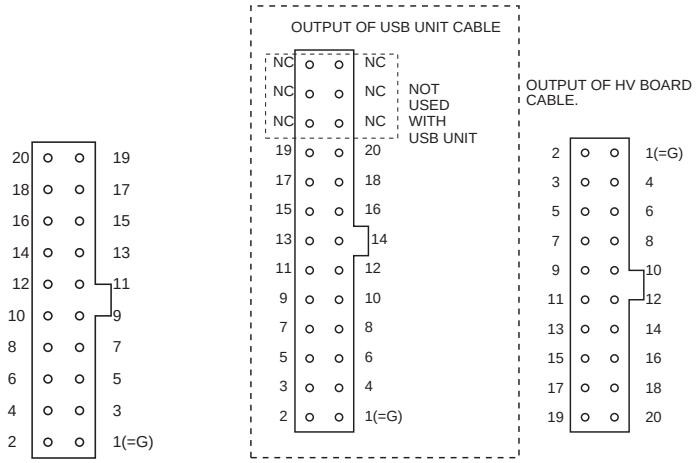

Figure 6: Pinouts of the first connector of the "DAC-40-USB" unit and cables. The numbers correspond to the numeration of "DAC-40-USB" output channels. Second connector is connected in a similar way.

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 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. 7. **NB!** The interferograms were registered at wavelength $\lambda = 630$nm in interferometer with total aperture less than 50mm.

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 cables, switch on the HV unit` — **first** connect the cables and **then** switch on the HV unit.
- The system supplied to you is ready for run after all cables are connected – *you don't need to change anything in the hardware configuration.*
- All following operations refer to DAC-40-USB units connected to a computer running Windows (we used XP SP2 for final tests) and 40-channel HV units.
- Connect the DAC USB units to the computer USB ports directly or through the USB Hub. Install the DAC USB software (refer to the DAC USB unit guide).

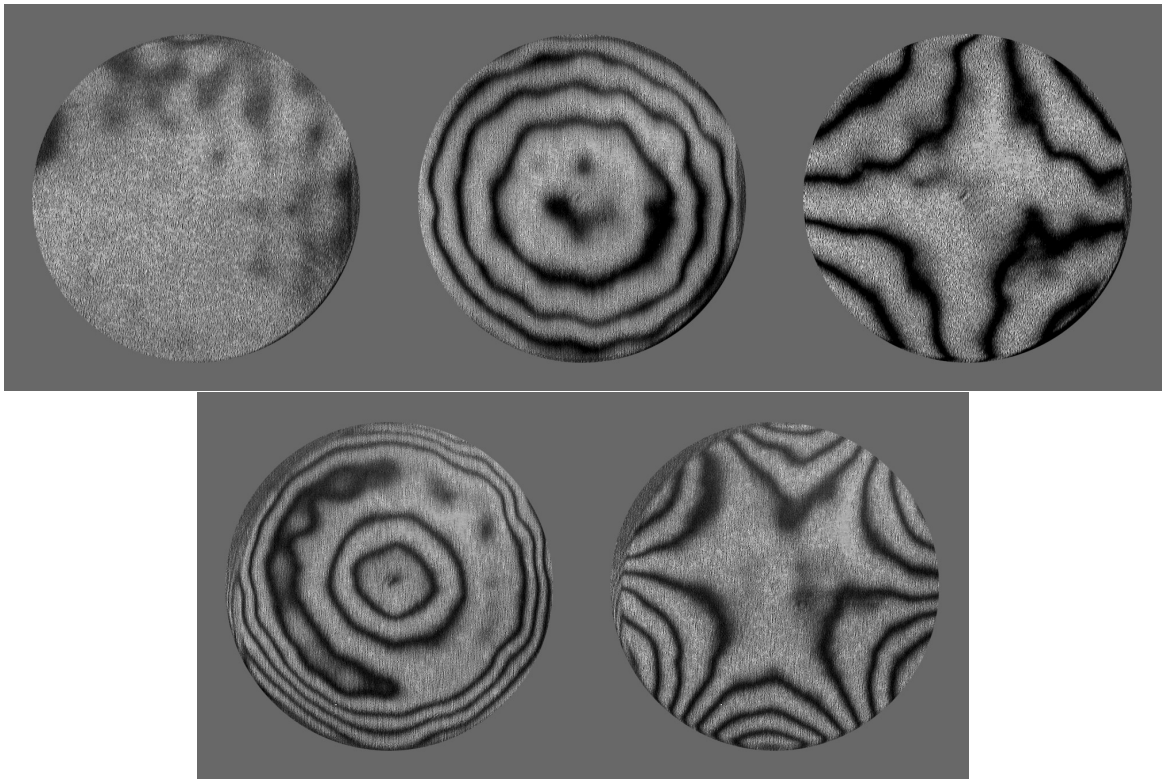

Figure 7: Test of the mirror: mirror flattening (initial aberration corrected), defocus, astigmatism, spherical aberration and trefoil genearted.

- Connect ground terminals of all 3 HV amplifier units together using supplied wire cable (the ground connectors are located on the back panel of the HV units, see Fig. 4 for reference). *Do not switch on the HV units yet!*
- Connect DAC USB units to the inputs of HV units using supplied ribbon cables with 20- and 26-way connectors. *Mind the cable and connector numbering!*
- Connect HV unit outputs to the mirror. *Mind the cable and connector numbering!*
- Remove the lid from the mirror case. Place the mirror into interferometer or a setup with a wavefront sensor. Fix the cables to the optical table. You can also test the mirror by reflecting a good collimated beam from the mirror surface and observing the near field intensity distribution.
- Control the initial mirror figure (should be close to sphere).
- Switch on the amplifier units. The control LEDs should glow evenly, without blinking. Blinking LED indicates failure of a hardware component of the HV amplifier unit. *Never use an HV amplifier unit with blinking LED!*
- Use test programs (e.g. `rotate.exe` or `degauss.exe` to verify that all channels function correctly.
- You may start to use the mirror if all channels work. Use the source code supplied as a template to write your own control programs.

6 Remarks

For OEM version. **Use high-quality stabilized filtered high-voltage supply.** Some high-voltage supplies generate short high-voltage spikes at the output, these deviations can destroy the mirror, driver electronics and even the control computer. Do not turn on V_high directly to its maximum value. Set V_high to 100V before switching the system off. Switch the system on with V_high not higher than 120V. Increase V_high to its working value after switching on the digital boards and setting the control voltages to zero.

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

The mirror surface can be cleaned using any standard procedure for cleaning dielectric mirrors.

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.

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8 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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