Piezoelectric Tip-tilt Mirror

technical passport

OKO Technologies,

OKO Technologies is the trade name of Flexible Optical BV

Table 1: *Technical parameters of the fast steering mirror.*

Parameter	Value
Active axes	θ_x, θ_y (3 point suspension)
Number of actuators	3
Actuator pitch, p	6mm
Maximum actuator stroke, s	6μm @ 300V
	8μm @ 400V
Control voltage range	
(with respect to the ground electrode)	$0 \ldots +300$V (recommended)
	$0 \ldots +400$V (maximum)
Actuator capacitance C_a	15 nF
Hysteresis, typical	7-12%
Dimensions, mm	$30 \times 30 \times 70$
Body material	Al
Weight	300 g
Motion and positioning	
Control type	open loop
Range, minimal	1 mrad optical (see Fig. 5)
Resolution	defined by DAC interface
Full range scanning speed	0.5 ms with a 25mm, 6mm mirror
Resonant frequency	1.28 kHz with a 25mm, 6mm mirror
Frontplate recommended	
Diameter	25.4mm
Thickness	6mm
Driver	
Shipped with	tip-tilt driver unit# D4V1d027
Interface	USB 2.0
Number of output channels	3
Resolution	16 bits (65536 levels)
Maximum update frequency	1 kHz
Output voltage range	0..300V (Tunable)
Mirror serial number	16.14

1 Technical specifications

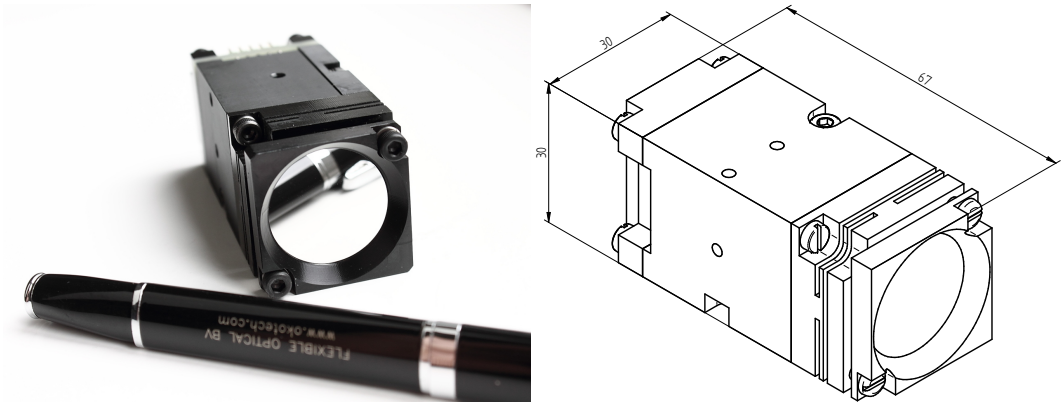

Figure 1: *Piezoelectric fast steering mirror*

The fast steering platform, shown in Fig. 1, is controlled by 3 piezoelectric actuators.

See Table 1 for the typical technical parameters of the platform.

By default, the device is supplied without optical part. Any front surface mirror with diameter from 10 to 25 mm can be mounted on the fast steering platform.

The typical frequency range with a round 25 mm mirror is up to 300 Hz, the optical tip-tilt range is 1 mrad.

2 Connection to the control electronics

The unit can be controlled by a single A4MEMS high-voltage amplifier.

The computer interface is provided by either EDAC40, USB DAC40, or USB DAC4.

A three-channel high voltage driver combines USB DAC4 and A4MEMS in a single housing box (see Fig. 2). To use the driver, connect it to the wall outlet (85 to 250 V AC, 50 to 60 Hz), to a USB port computer and to the tip-tilt mirror. The ground pin of the tipt-tilt should be connected to the ground pin of the output connector (see Fig. 3).

3 Control of the mirror

The mirror head is suspended on tree piezoelectric actuators (see Fig. 4), without a fixed pivot point. The normal to the mirror head surface is defined by actuator displacements (d_1, d_2, d_3) as

$$(d_3 - d_1, d_2 - d_1, p), \tag{1}$$

where p is the actuator pitch. Setting a linear constrain on the actuator displacements will provide a virtual pivot point at the expense of decreased angle range.

Figure 2: *Three-channel high voltage driver includes power supply, USB DAC4, and A4MEMS*

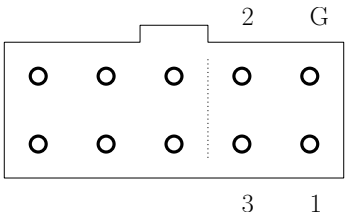

Figure 3: *Output connector of a three-channel high voltage driver*

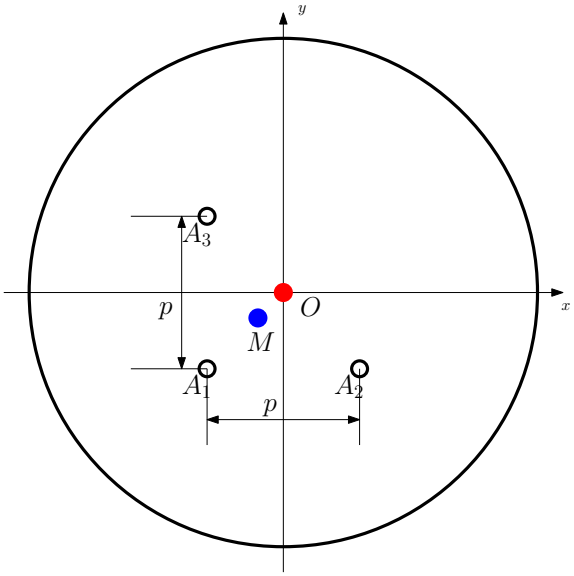

Figure 4: *Position of the actuators (A_1, A_2, and A_3) with respect to the 25mm mirror plate*

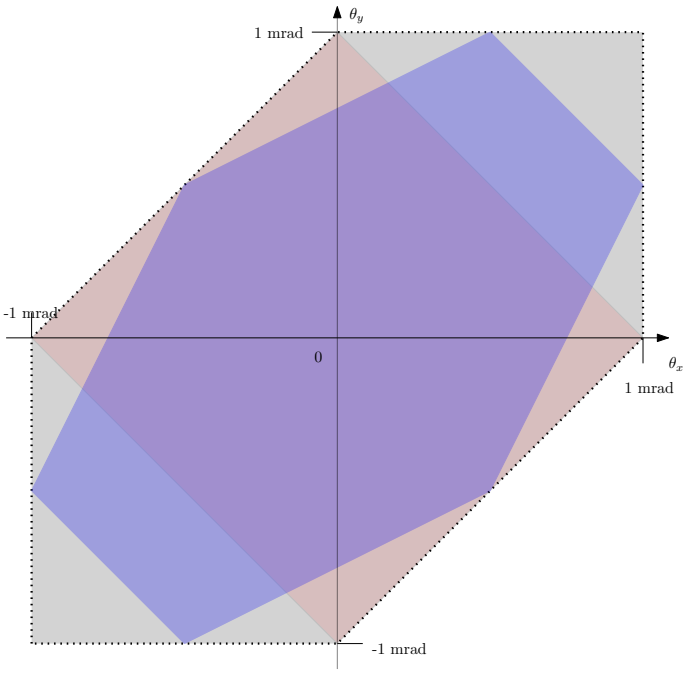

Figure 5: *Optical range of the tip-tilt mirror: full (gray), with virtual pivot point at the mirror center (red) and in point M (blue)*

For instance, the following constrain

$$d_1 + d_2 + d_3 = 3s/2, \tag{2}$$

where s is the actuator stroke, will place the pivot in point M (center of gravity of actuator positions, see Fig. 4), and this constrain

$$d_2 + d_3 = s \tag{3}$$

will place the pivot in the origin (point O on Fig. 4).

Please see the source code of `fullRange.exe` and `setTilt0.exe` in `sample programs` folder on the supplied CD for illustration. Yo can run the programs from the command line window or double clicking on them and monitor a reflected laser beam on a screen to see the results.

4 Special remarks

By demand of the customer the tip-tilt stage is supplied without faceplate. To improve flatness it is recommended to bond the mirror directly, although it is also possible to use a metal frame (supplied).

5 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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6 Contact person

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Signature:

(Seva Patlan, PhD
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