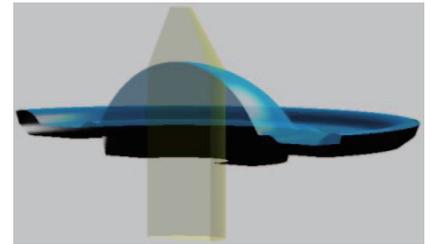
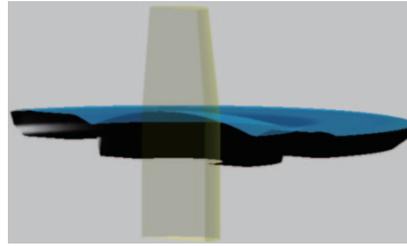


# Fast Electrically Tunable Lens EL-6-18



## Fast Electrically Tunable Lens EL-6-18

The curvature of this shape changing polymer lens can be adjusted by applying current. The focal length is accordingly tuned to a desired value within milliseconds. The following table outlines the specifications of the standard EL-6-18-VIS-LD.

## Working principle

The EL-6-18 is a shape-changing lens. It consists of an injection-molded container, which is filled with an optical fluid and sealed off with an elastic polymer membrane. The deflection of the lens is proportional to the pressure in the fluid. The EL-6-18 has an electromagnetic actuator that is used to exert pressure on the container. Hence, the focal distance of the lens is controlled by the current flowing through the coil of the actuator.

### Mechanical specifications

Dimensions (L x W x H)	18 x 19.3 x 8.7 mm
Clear aperture	6 mm
Weight	6.7 g
Lifecycles (10-90% sinusoidal)	>1'000'000'000
Vibration resistance	IEC 60068-2-6: 10G (10-50 Hz) in operation
Drop test	50 drops from 2 m

### Electrical specifications

Resistance (@ 20°C)	8.8 +/- 0.4 Ω
Control current (typical)	0 to 200 mA
Power consumption	0 to 350 mW
Response time (10%-90% step)	<2 ms
Settling time	<10 ms
Electrical connection	6 way 0.5mm pitch
Integrated temperature sensor / memory	STTS2002

### Optical specifications

Focal tuning range at STP <sup>1</sup>	-500 to +50 mm (-2 to 20 dpt)
Wavelength range <sup>2</sup>	400 to 700 nm
Dispersion (at 20°C)	$n_F$ (486.1nm) 1.302
	$n_D$ (589.3nm) 1.300
	$n_C$ (656.3nm) 1.299
	Abbe number $V_d$ 100
Lens type	Meniscus (concave-convex)
Full field of view	40°
Polarization	Preserving

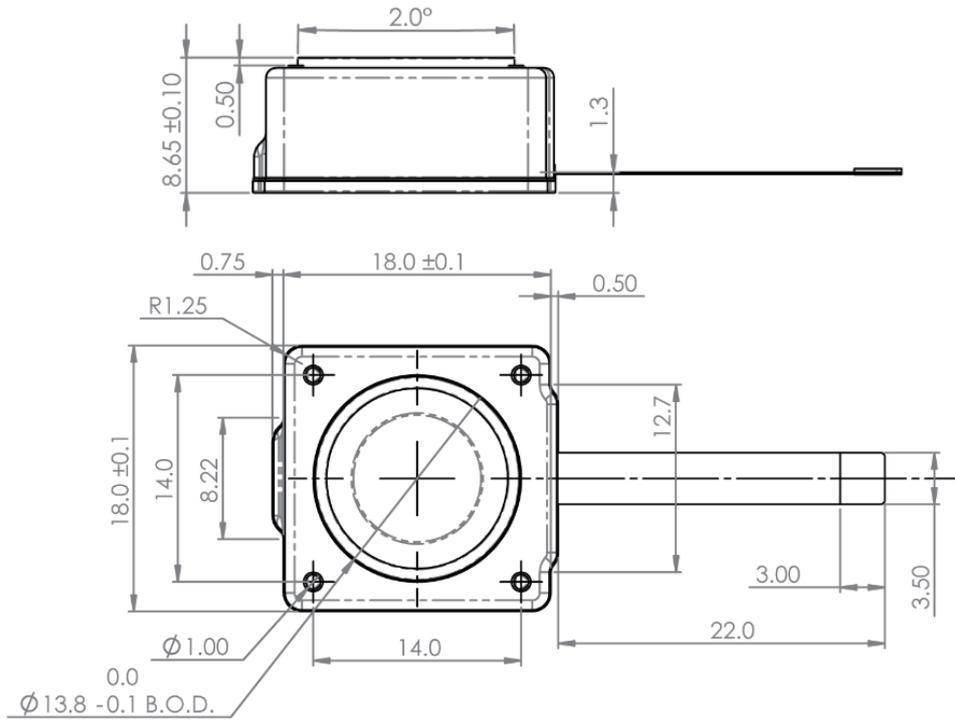
### Thermal specifications

Operating temperature	-20 to +70 °C
Storage temperature	-40 to +85 °C

### Regulatory Requirements

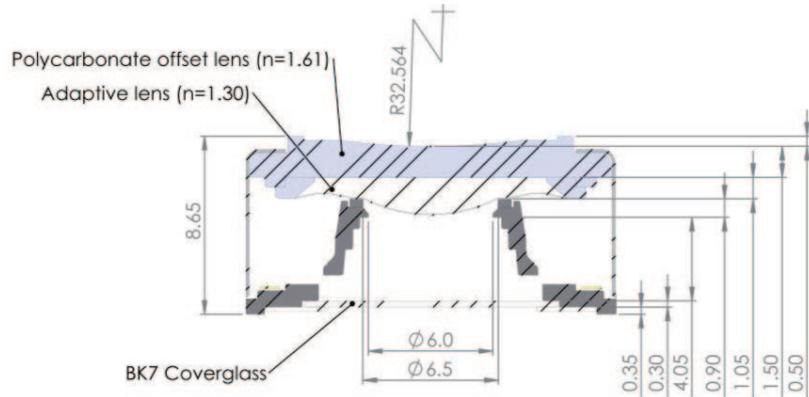
Materials	Complies with EU directive 2002/95/EC (RoHS)
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**Mechanical Dimensions (unit: mm)**



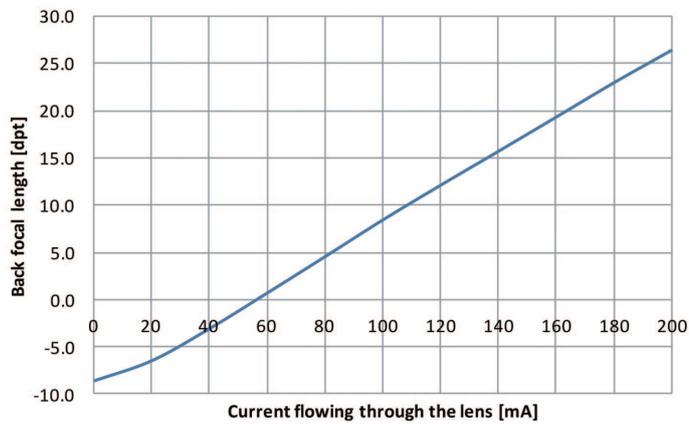
**Optical Layout**

The focal range of the tunable lens itself is limited to the positive range. To expand the tuning range to negative focal lengths, the EL-6-18 has an offset lens with a negative focal length of -50 mm. All optically relevant dimensions are referenced to a ring on the container, which protrudes the housing.

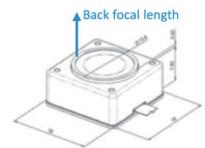


**Focal length versus current**

The focal power of the EL-6-18 increases with current. The starting point at zero current is set during production and can be varied from lens to lens. The slope of the focal length decrease is influenced by the mechanical properties of the membrane, which can also be varied on request to achieve different ranges of focal length. In open loop systems, a calibration of the lens with look-up tables is recommended.

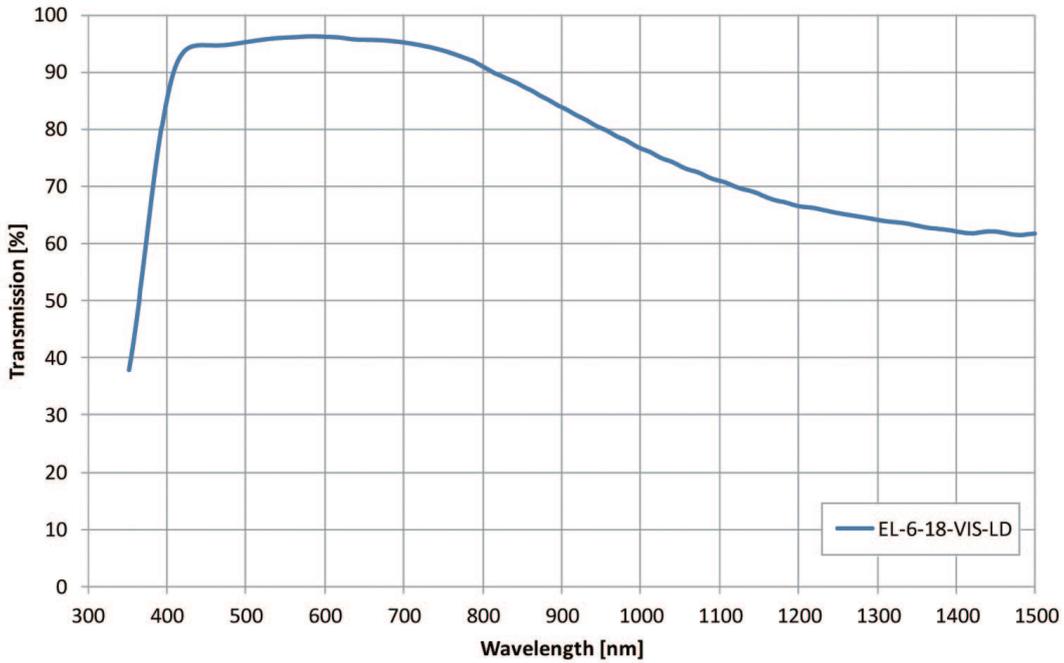


Typical relation of focal length to current of the EL-6-18



**Transmission range**

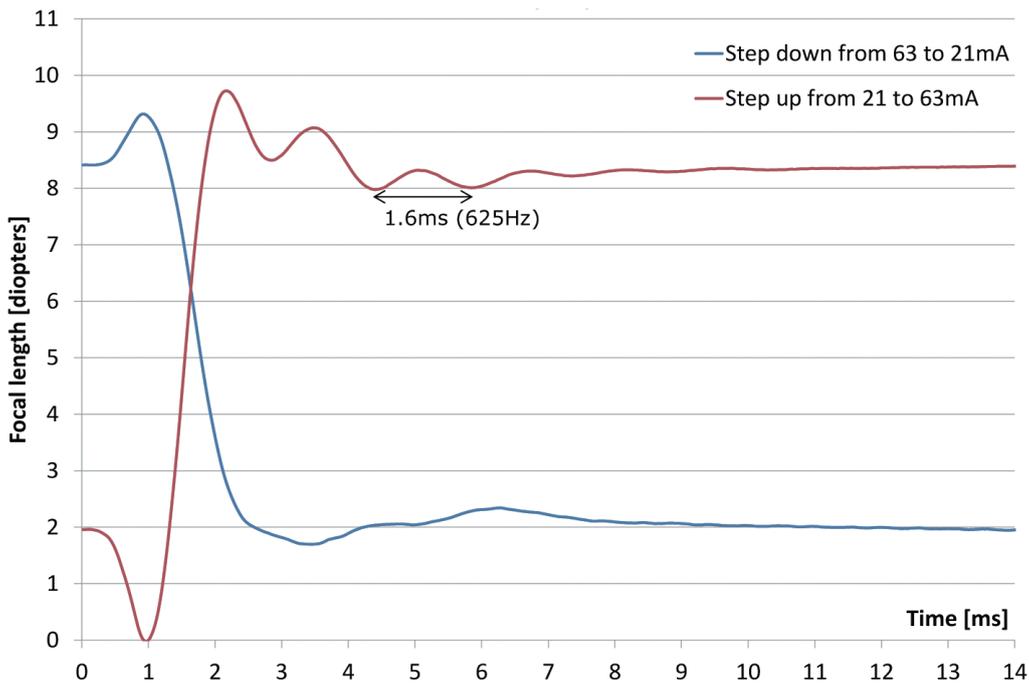
Both the optical fluid and the membrane material are highly transparent and hardly absorbing in the range of 250 – 2500 nm. As the membrane is elastic it cannot be coated using standard processes, hence a reflection of 3 – 4% is to be expected. The standard cover glasses have a broadband anti-reflection coating for visible light.



Transmission spectrum of the EL-6-18 for standard VIS coated cover glasses (400-700 nm)

**Step response time**

The rise time on a current step is about 2 ms. However, it takes about 10ms until the lens has fully settled. The following graph shows the optical response on a current step measured using the astigmatic lens approach with a cylinder lens and a quadrant diode.



Optical response of the EL-6-18 to a current step from 21 to 63 mA and back