Fast Electrically Tunable Lens
EL-10-30 Series

The curvature of this shape changing polymer lens is adjusted by applying current. The focal length is accordingly tuned to a desired value within milliseconds. Optotune offers three different types of housings of the EL-10-30. The compact 30x10.7 mm housing, a 30x20 mm housing with C-mount threads and the Industrial C-mount housing (Ci) with Hirose connector. For each housing there are different options to adapt the lens to your needs:

- High refractive (HR) liquid (n_D=1.559, V=32) & low dispersion (LD) liquid (n_D=1.302, V=100)
- Diverse cover glass coatings
- Optional offset lenses

The table below summarizes the possible options for the three different housings. At the end of this document you find a detailed explanation of the naming concept when ordering a customized EL-10-30.

Option	EL-10-30	EL-10-30-C	EL-10-30-Ci
Optical material	LD, HR	LD	LD
Cover glass coatings	VIS[1], NIR[2]	VIS, NIR, 1064[3]	VIS, NIR, 1064
Optional offset lens	No	Yes	Yes

[1]400-700 nm broad band [2]700-1100 nm infra-red broad band [3]narrow band 1064 nm

The following table outlines the specifications of our standard electrically tunable lens EL-10-30. Cover glass coatings and tuning range can be adapted on demand.

Mechanical specifications	EL-10-30	EL-10-30-C	EL-10-30-Ci	
Clear aperture	10	10	10	mm
External diameter	30	30	Oval shape 48x30.5	mm
Thickness	10.75	24.6	24.6	mm
Weight	22.9	34.0	46.0	g
Connector length	300	100	1000	mm
Lifecycles (10-90% sinusoidal)	>1‘000‘000‘000	>1‘000‘000‘000	>1‘000‘000‘000	
Temperature sensor & memory	-	Yes (SE97B)	Yes (SE97B)	

Electrical specifications		
Absolute maximum voltage	5	V
Control current	0 to 300	mA
Power consumption	0 to 1.1	W
Response time (10%-90% step)	<2.5	ms
Settling time (typical at 25°C)	15 (rectangular step), 6 (controlled step)	ms

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Optical specifications	EL-10-30 (HR liquid)	EL-10-30 (LD liquid)	EL-10-30-C & Ci (LD liquid)	
Focal tuning range[1]	+20 to +60	+45 to +120	+80 to +200	mm
Dispersion (at 20°C) 486 nm	1.572	1.302	1.302	
589 nm	1.559	1.300	1.300	
656 nm	1.554	1.299	1.299	
800 nm	1.546	1.298	1.298	
1065 nm	1.541	1.297	1.297	
1550 nm	1.535	1.296	1.296	
Abbe number V	32	100	100	
Wavefront error (@525 nm, 0 mA) Optical axis vertical / horizontal	<0.3 / <0.8	<0.2 / <0.5	<0.15 / <0.25	λ RMS
Lens type		plano-convex		
Transmission spectrum		see Figure 8		
Optical damage threshold @ 1064 nm		10		kW/cm²
Centration		<2		arcminutes
Polarization		preserving		

Thermal specifications	EL-10-30 (HR liquid)	EL-10-30 (LD liquid)	EL-10-30-C & Ci (LD liquid)	
Storage temperature	[-40,+85]	[-40,+85]	[-40,+85]	°C
Operating temperature	[-5,+65]	[-20,+65]	[-20,+65]	°C

Overview of available standard products

Standard products	Tuning range[1]	Refractive index	Cover glass coating	RMS wave-front error[2]	Integrated offset lens	Tempera-ture sensor
EL-10-30-VIS-LD	+8to +22 dpt	1.30	400 – 700 nm	<0.50 λ	No	No
EL-10-30-NIR-LD	+8 to +22 dpt	1.30	700 – 1100 nm	<0.50 λ	No	No
EL-10-30-VIS-HR	+16.5 to +50 dpt	1.56	400 – 700 nm	<0.50 λ	No	No
EL-10-30-C-VIS-LD	+5 to +12.5 dpt	1.30	400 – 700 nm	<0.25 λ	No	Yes
EL-10-30-C-NIR-LD	+5 to +12.5 dpt	1.30	700 – 1100 nm	<0.25 λ	No	Yes
EL-10-30-C-VIS-LD-MV	-1.5 to +6 dpt	1.30	400 – 700 nm	<0.25 λ	Yes (-150 mm)	Yes
EL-10-30-C-NIR-LD-MV	-1.5 to +6 dpt	1.30	700 – 1100 nm	<0.25 λ	Yes (-150 mm)	Yes
EL-10-30-C-1064-LD-LP	-1.5 to +2.5 dpt	1.30	1064 nm	<0.12 λ	Yes (-150 mm)	Yes
EL-10-30-Ci-VIS-LD	+5 to +12.5 dpt	1.30	400 – 700 nm	<0.25 λ	No	Yes
EL-10-30-Ci-NIR-LD	+5 to +12.5 dpt	1.30	700 – 1100 nm	<0.25 λ	No	Yes
EL-10-30-Ci-VIS-LD-MV	-1.5 to +6 dpt	1.30	400 – 700 nm	<0.25 λ	Yes (-150 mm)	Yes
EL-10-30-Ci-NIR-LD-MV	-1.5 to +6 dpt	1.30	700 – 1100 nm	<0.25 λ	Yes (-150 mm)	Yes
EL-10-30-Ci-1064-LD-LP	-1.5 to +2.5 dpt	1.30	1064 nm	<0.12 λ	Yes (-150 mm)	Yes

Housings

The compact EL-10-30 is preferably mounted in a 30 mm ring holder. The relevant mechanical drawings are depicted below in Figure 1. Figure 2 shows the drawings of the C-mount housing. This housing has threads on either side and exhibits an M4 threaded hole in the housing for mounting on optical posts. Figure 3 shows the drawings of the industrial C-mount EL-10-30-Ci. This housing has an oval shape and no M4 threaded hole, however C-mount threads on either side like the C-mount housing. Apart from the housing and connector, the performance of the EL-10-30-C and EL-10-30-Ci are identical.

[1] Different focal tuning ranges available upon request
[2] Wavefront error in RMS λ @525 nm, 0 mA current with optical axis horizontal (worst case)

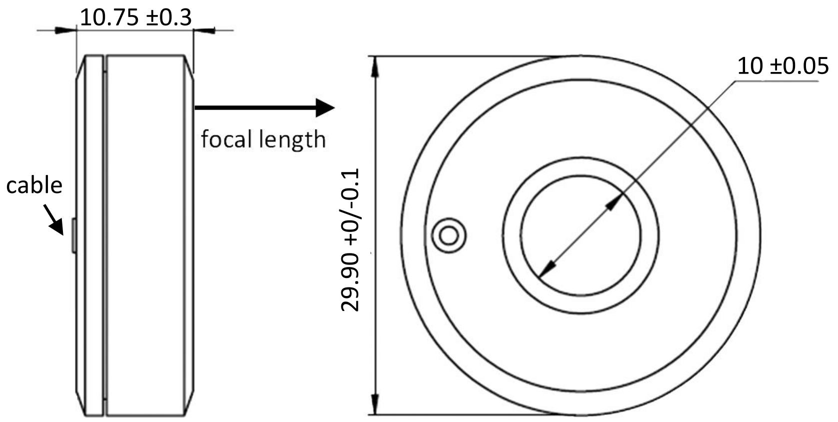


Figure 1: Mechanical drawing of the compact EL-10-30 (unit: mm).

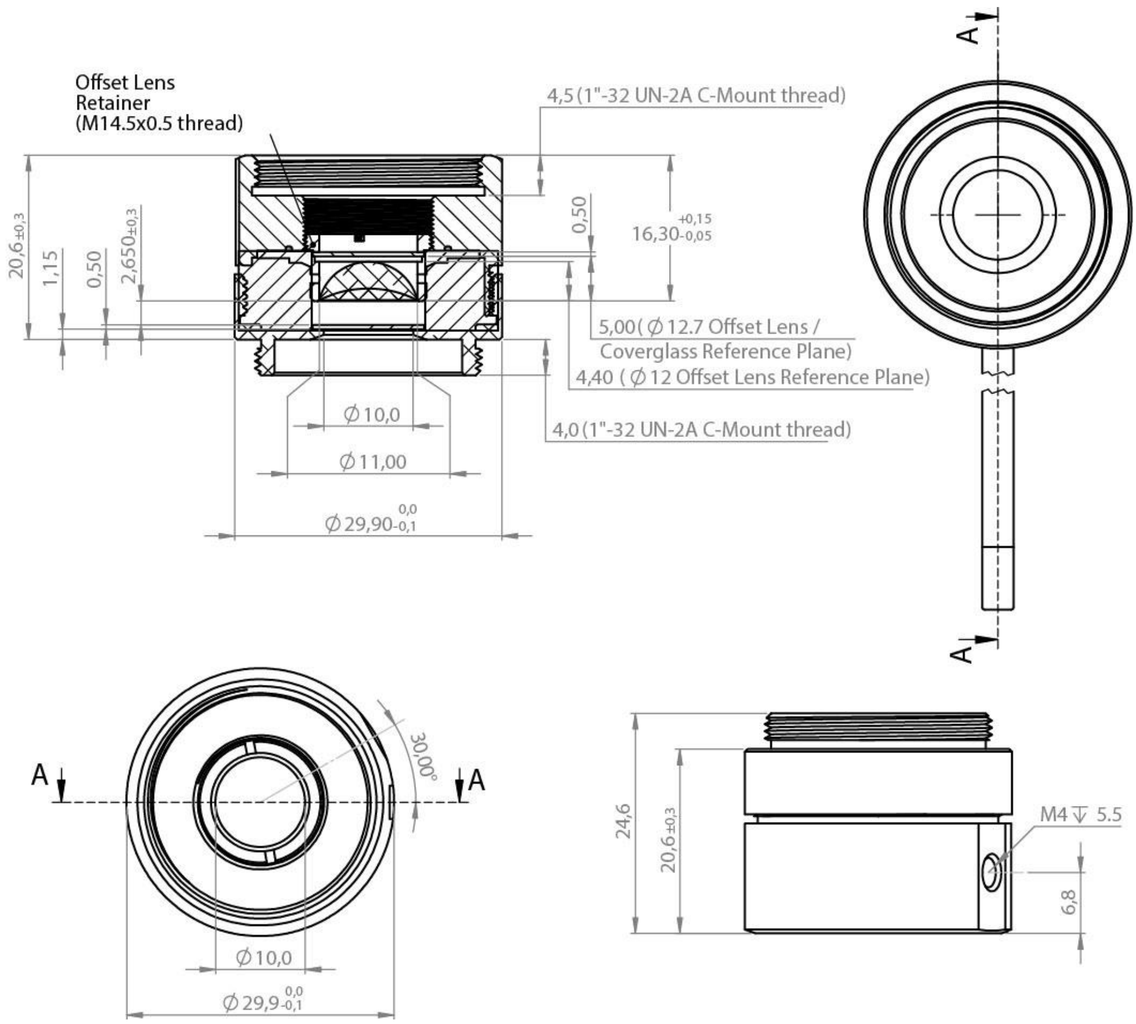


Figure 2: Mechanical drawing of the EL-10-30-C (unit: mm). The lower panel shows the position of the M4 threaded hole for mounting of the EL-10-30-C

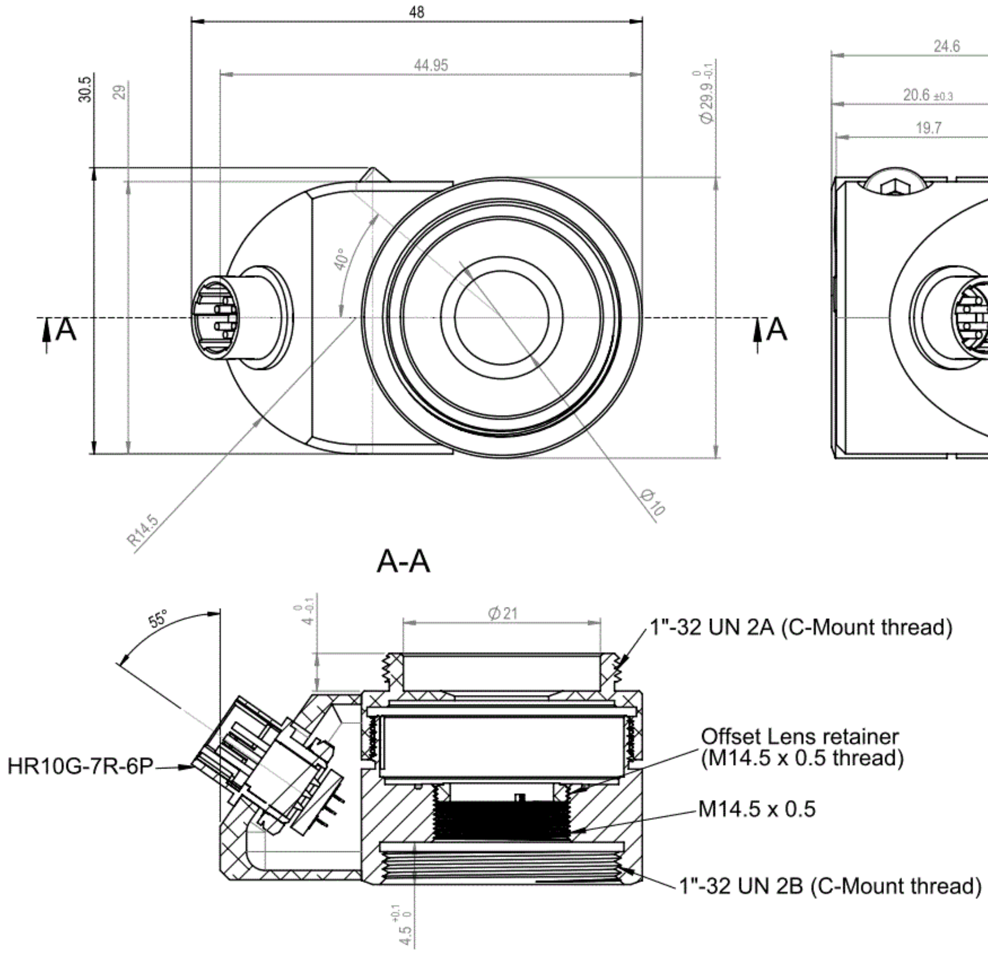


Figure 3: Mechanical drawing of the industrial C-mount EL-10-30-Ci (unit: mm).

Electrical connection

The compact EL-10-30 has a 30cm long cable for driving current through the lens. Figure 4 shows the multi-pin connection of the EL-10-30-C (left) and EL-10-30-Ci (right). The EL-10-30-C has a 10cm long FPC connection, which is compatible with Molex 0.5mm pitch 6 way FPC backflip connector (P/N 503480-0600). Samples ship with an adaptor for easy soldering. The industrial design EL-10-30-Ci comes with a 6-pin Hirose connector. A 1m long cable to connect the EL-10-30-Ci to the EL-E-4i driver is available from Optotune (P/N CAB-6-100). Both the EL-10-30-C and –Ci feature an SE97B temperature sensor with 256 bytes of memory.

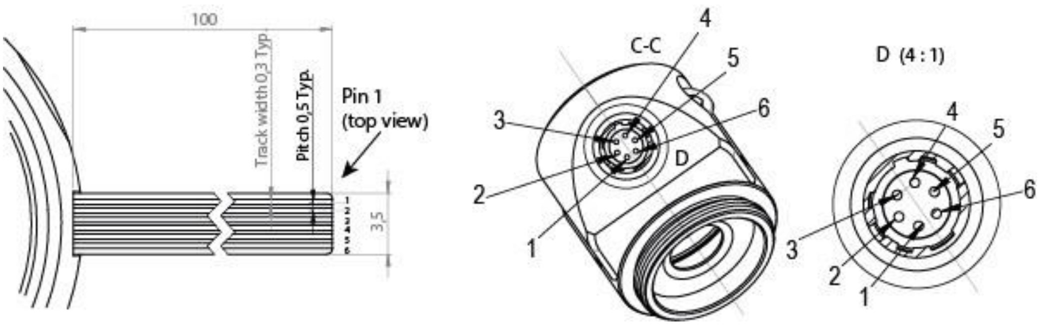
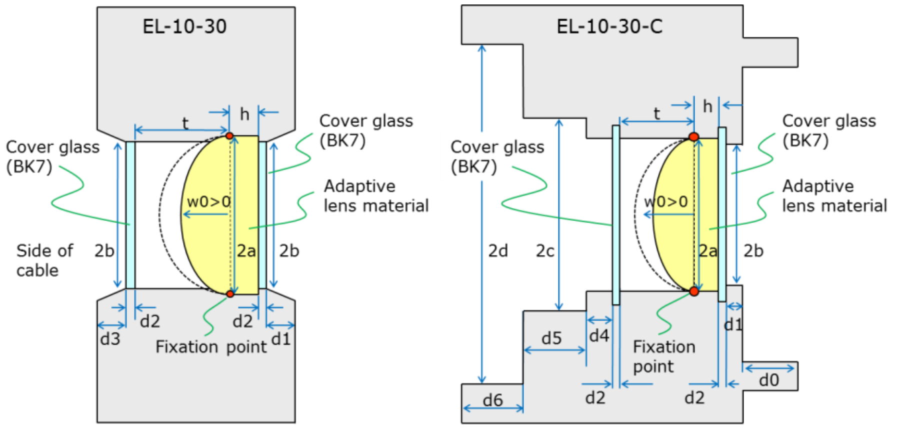


Figure 4: Mechanical drawings for the different types of connection for EL-10-30-C (left) and EL-10-30-Ci (right)

Pinning EL-10-30-C			Pinning EL-10-30-Ci		
Position	**Function**	**SE97B Pins**	**Position**	**Function**	**SE97B Pins**
1	SE97B Gnd	1-4	1	SE97B SDA	5
2	Lens (- pole)	-	2	SE97B SCL	6
3	Lens (+ pole)	-	3	SE97B Power	8
4	SE97B SDA	5	4	SE97B Gnd	1-4
5	SE97B SCL	6	5	Lens (- pole)	-
6	SE97B Power	8	6	Lens (+ pole)	-

Optical layout

Figure 5 contains the information needed to model the EL-10-30 lenses for simulation. A more detailed design guide and a ZEMAX plug-in is available



		EL-10-30 [mm]	EL-10-30-C [mm]
a:	Semi-diameter of lens	5.5	5.5
b:	Outer semi-diameter 1 (clear aperture)	5.0	5.0
c:	Inner semi-diameter	-	7.0
d:	Outer semi-diameter 2	-	11.9
w0:	Central deflection of lens	In function of applied current	
d0:	Thickness outer thread	-	4
d1:	Distance from bottom cover glass to housing	1.15	1.15
d2:	Thickness of cover glasses	0.5	0.5
h:	Constant zone of lens material	2.45 ± 0.3	2.65 ± 0.3
t:	Cover glass distance	5	5
d3:	Distance from top cover glass to housing	1.1	-
d4:	Thickness holder ring	-	2
d5:	Distance from holder ring to housing	-	4.3
d6:	Thickness inner tread	-	4.5
Fixation point:	Lens edges always stay in the same axial position		

Figure 5: Optical layout of the EL-10-30 and EL-10-30-C with corresponding terminology. The optical design for the EL-10-30-Ci is identical to the C-mount version.

Using offset lenses

In the EL-10-30-C and -Ci the protective cover glass can be replaced by an offset lens of 12 or 12.7-mm diameter. This allows shifting the focal length range to any desired value. For example, adding an offset lens with f = -150 mm to the EL-10-30-C-VIS-LD will yield a focal length range of about -600 mm to infinity to +170 mm ($1/f_{res} = 1/f_{EL\text{-}10\text{-}30} + 1/f_{offset}$). The design of the EL-10-30-C is optimized for good alignment of the tunable lens and the offset lens. The maximal thickness of the offset lens may be 4.7 mm.

Working principle

The EL-10-30 is a shape-changing lens, as illustrated in Figure 6. It consists of a 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-10-30 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.

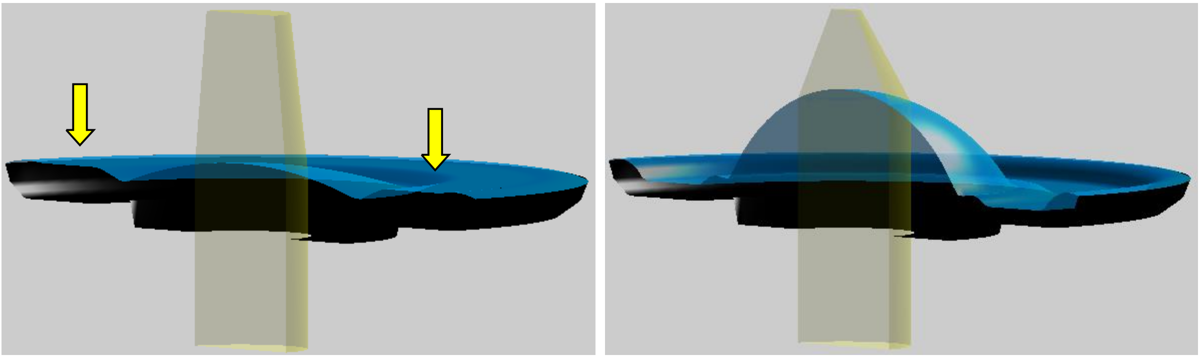


Figure 6: Working principle of the EL-10-30.

Focal length versus current

The focal power of the EL-10-30 increases with increasing current, shown in Figure 7. The starting point at zero current is set during production and can be varied from lens to lens, whereas the maximal value is 500 mm. The slope of the focal power is influenced by the mechanical properties of the membrane, which can also be varied on request to achieve different ranges. In open loop systems, a calibration of the lens with look-up tables is recommended. The focal length of the EL-10-30 lenses also depends on the temperature, see paragraph *temperature effects*.

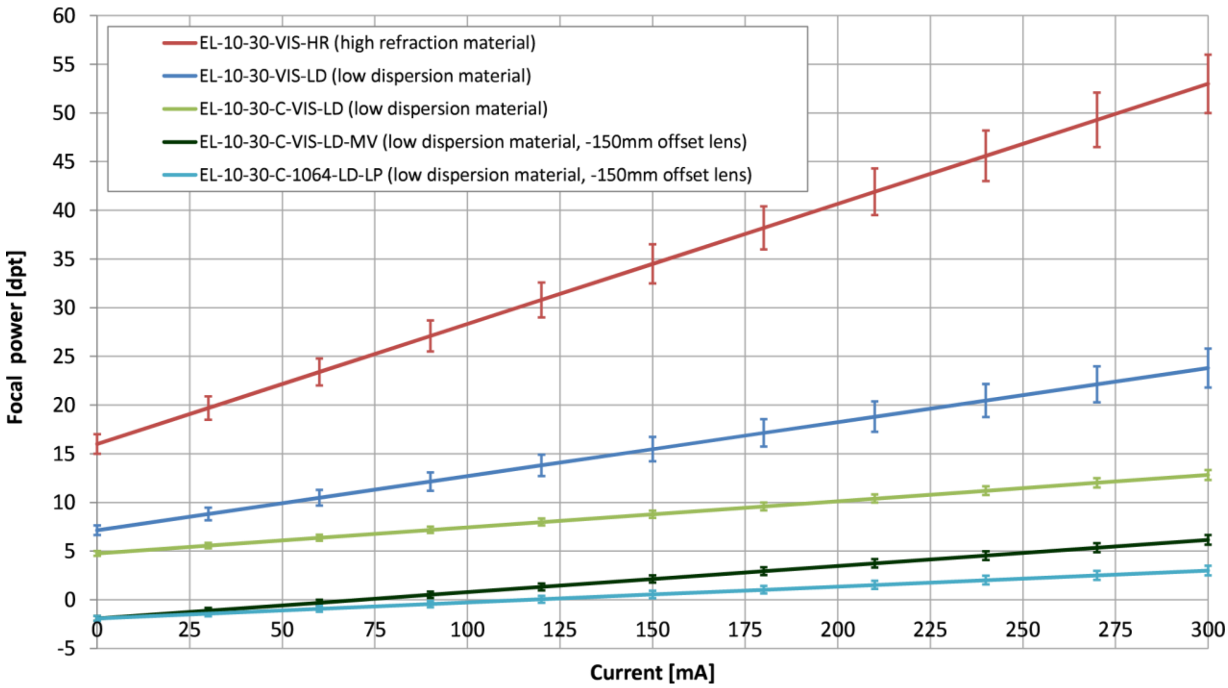


Figure 7: Typical relation of optical power (in diopters) to current for the most common EL-10-30 variations at room temperature. The error bars show the standard deviation from lens to lens.

Transmission range

Both the optical fluid and the membrane material are highly transparent in the range of 400 to 2500 nm. As the membrane is elastic it cannot be coated using standard processes, hence a reflection of 3 – 4% is to be expected. Cover glasses can be coated as desired. Figure 8 and Figure 9 show the transmission spectrum for our two standard broad-band coatings (visible and near infrared) as well as two custom narrow-band coatings:

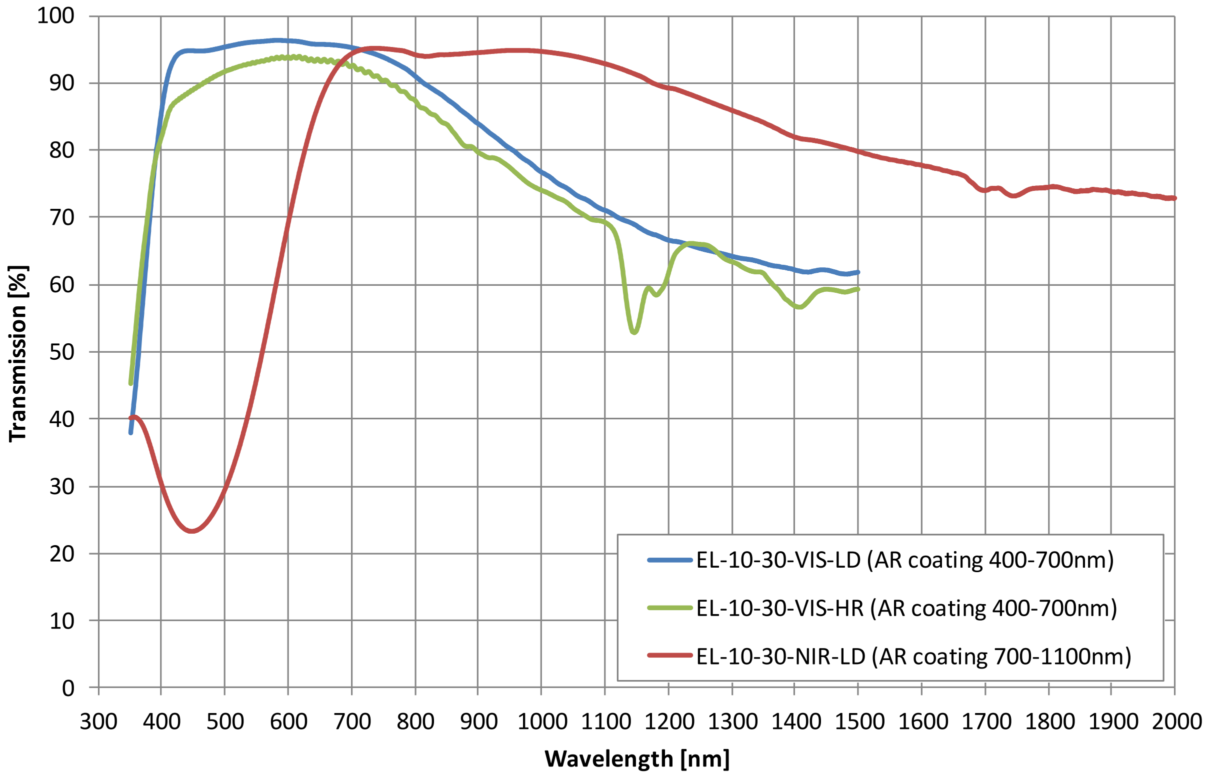


Figure 8: Transmission spectrum of the EL-10-30 for standard broad-band coatings.

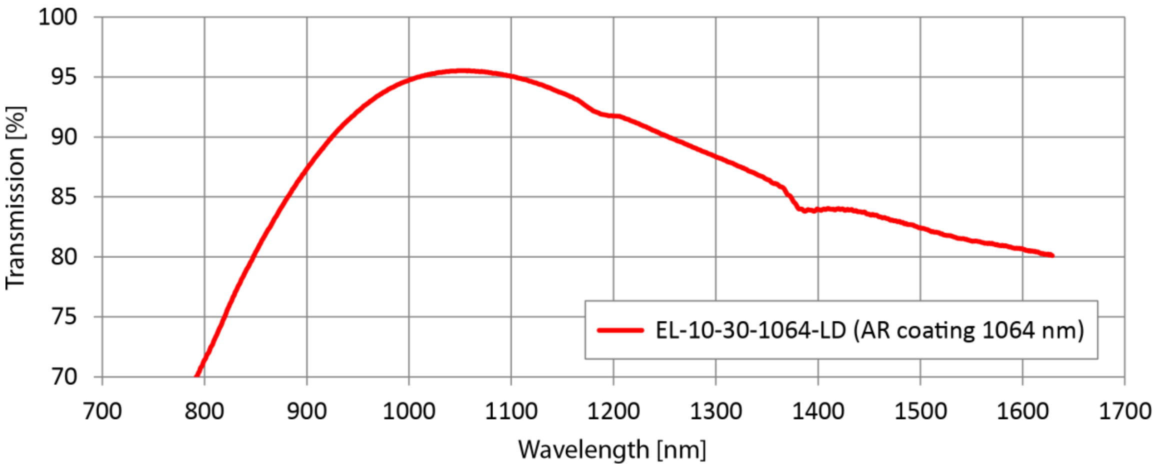


Figure 9: Transmission spectrum of the EL-10-30 for narrow-band 1064-nm coating.

The following graph (Figure 10) represents the transmission of the lens material only[3], i.e. assuming perfect cover glasses.

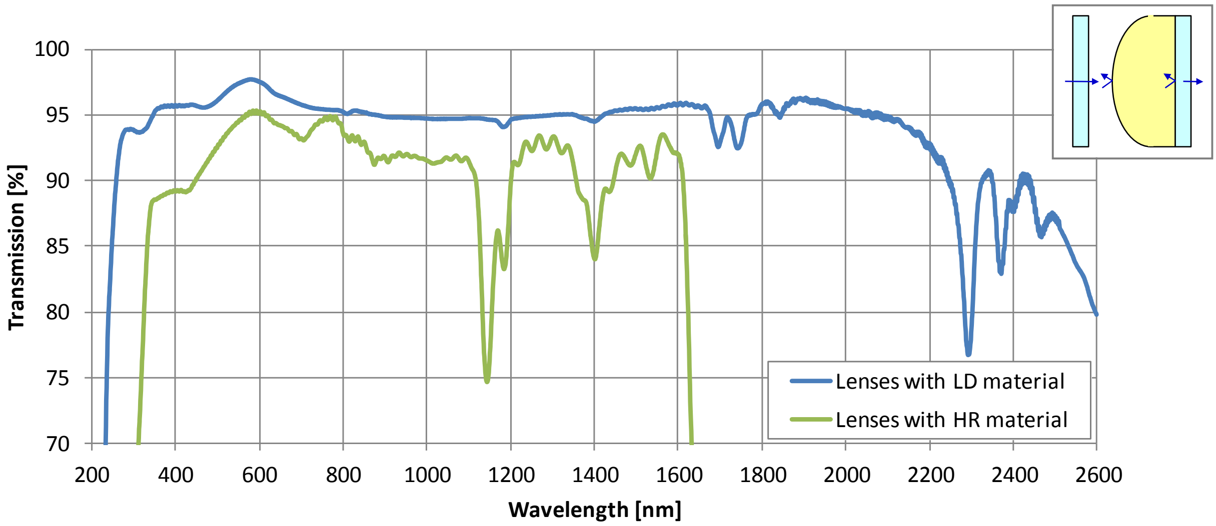


Figure 10: Transmission of the EL-10-30 assuming 100% transparent cover glasses.

Wavelength [nm]	EL-10-30-VIS-LD	EL-10-30-VIS-HR	EL-10-30-NIR-LD	EL-10-30-1064-LD	Lens with LD Material[2]	Lens with HR Material[2]
375	61.7	67.4	38.2	50.7	95.7	88.9
405	88.3	83.5	29.1	66.8	95.7	89.3
440	94.8	88.4	23.5	88.6	95.8	89.5
488	95.1	91.2	26.9	80.2	95.8	91.9
514	95.6	92.3	32.9	67.8	96.5	93.1
532	95.9	92.8	38.7	60.7	97.0	93.9
632	95.9	93.4	81.8	47.3	96.8	94.6
650	95.7	93.4	87.2	48.2	96.5	94.2
680	95.6	93.4	92.6	50.9	96.1	93.7
730	94.5	91.7	95.2	58.3	95.6	94.0
808	90.5	86.6	94.1	72.7	95.1	93.5
830	89.0	85.4	94.1	77.1	95.4	93.0
850	87.7	84.0	94.3	80.4	95.3	92.9
880	85.5	80.7	94.4	84.8	95.1	91.4
905	83.6	79.5	94.6	87.9	94.9	91.6
915	82.9	79.0	94.7	89.0	94.9	91.7
975	78.5	75.5	94.9	93.7	94.8	91.9
980	78.3	75.2	94.9	94.0	94.8	91.7
1030	74.9	72.8	94.4	95.4	94.7	91.4
1064	72.9	70.7	93.8	95.5	94.8	91.7
1070	72.7	70.3	93.7	95.4	94.8	91.9
1310	64.0	63.2	85.7	88.0	95.1	93.1
1540	NA	NA	78.9	81.5	95.6	90.4
1550	NA	NA	78.7	81.4	95.6	92.1

Table 1: Transmission values in percent of the EL-10-30 for common laser wavelengths

[3] The transmission of the „lens material only“ is put together from measurements of several lenses with differently coated cover glasses, whereas the three interfaces of „air to cover glass“ were removed mathematically.

Damage thresholds

The nominal specification of the lens materials used is 25 kW/cm². However, this number has not yet been sufficiently tested. Good results have been achieved with the following lasers:

- 1070 nm, 200 W CW on a 3 mm beam diameter (equivalent to 2.8 kW/cm²)
- 980 nm, 75 W CW on a 1.5 mm beam diameter (equivalent to 4.2 kW/cm²)
- 1064 nm, 20 ns-pulsed at 50 kHz, 10 W average power on a 0.05 mm beam diameter (10 J/cm²)
- 1064 nm, 12 ps-pulsed at 8.2 MHz, 38 W average power on a 2 mm beam diameter (147 µJ/cm²)
- 1064 nm, <15 ps-pulsed at 200 kHz, 50 W average power on a 7 mm beam diameter (650 µJ/cm²)
- 850 nm, 140 fs-pulsed at 80 MHz, 3 W average power on a 6 mm beam diameter (0.13 µJ/cm²)

While no heating up of the lens is observed with the pulsed lasers, a 200 W CW laser does heat up the lens, resulting in a focus drift, which stabilizes after about 10 seconds. To avoid heating up of the lens due to reflections hitting absorbing surfaces, it is advised to calculate such reflections and preferably not use more than 8 mm of the clear lens aperture.

Wavefront quality

In principle, Optotune's focus tunable lenses exhibit a spherical lens shape (the nominal parameters can be found in the ZEMAX package, which is available for download on).

As the membranes used are elastic, the lens shape is influenced by gravity. Results are summarized in Figure 11. With the lens lying horizontally (optical axis vertical), the RMS wavefront error of the EL-10-30 Series lenses is currently in the order of 0.1 λ (measured at 525 nm), allowing for high quality imaging e.g. in microscopy. With the lens standing upright (optical axis horizontal) a Y-coma term must be added.

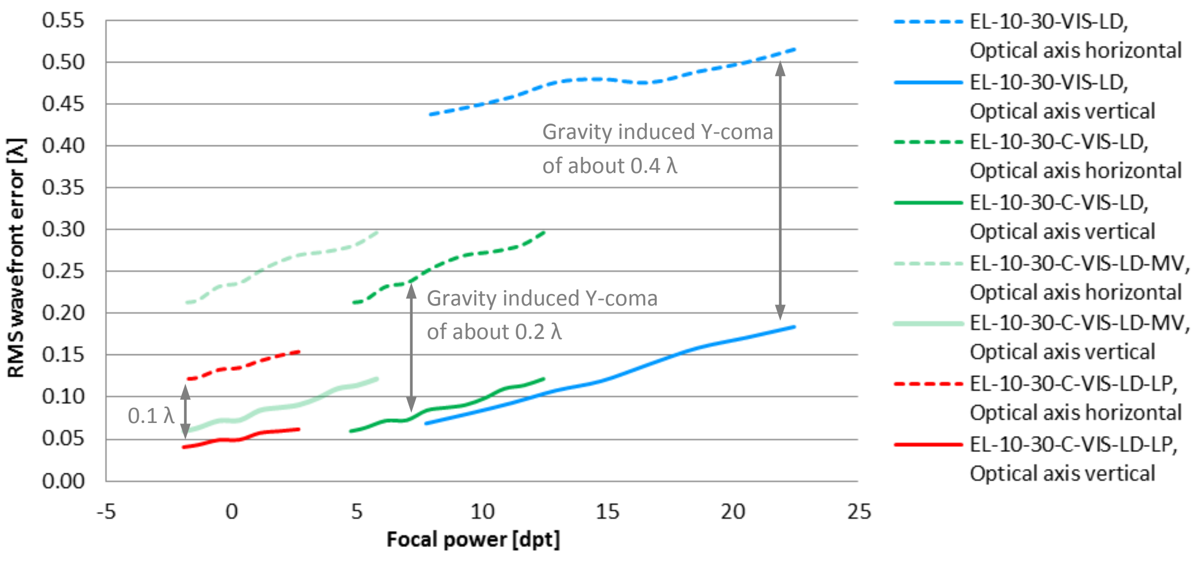


Figure 11: Wavefront measurement of typical EL-10-30-VIS-LD and EL-10-30-C-VIS-LD lenses at 525 nm and 80% of clear aperture, defocus, tilt & sphere excluded.

The gravity induced Y-coma term depends on the size of the lens, the density of the liquid and the mechanical properties of the membrane. While it is insignificant with lenses of apertures below 5 mm, it accounts for about 0.1 λ for the C-mount LP-version, 0.2 λ for the C-mount MV-version and 0.4 λ for the compact version of the EL-10-30. The difference between the different variations of the EL-10-30 lenses is the design of the membrane. The stronger membrane of the EL-10-30-C (with the LP version having the strongest membrane) reduces the gravity effect, however at the expense of focal tuning range (4 diopters for the EL-10-30-C-VIS-LD-LP, 7.5 diopters for the EL-10-30-C-VIS-LD and 14 diopters for the EL-10-30-VIS-LD, see Figure 7).

Temperature effects

Heating up of the lens has two consequences: First, the refractive index of the optical fluid decreases. Second, the fluid expands in volume. While the first effect would increase the focal distance, the second effect reduces it. With the EL-10-30 design, the second effect prevails. The focal distance decreases by approximately 0.6 diopters per 10°C temperature increase.

This temperature effect is systematic and reproducible. This means the focal length can be controlled if the temperature is known. The EL-10-30-C and EL-10-30-Ci have a built-in temperature sensor (SE97B). The compact EL-10-30 does not have that sensor, but measuring the resistance of the coil (voltage divided by current) can serve as a proxy for the temperature in the lens.

Heating up of the lens occurs at room temperature if driven at high currents or due to absorption of high power laser light. In such cases the lens is preferably mounted using heat-conducting metal clamps. For custom designs it is possible to balance the two temperature effects such that the focus shift becomes minimal at a certain focal length.

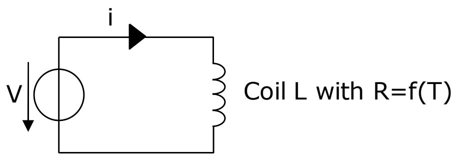
Resolution and reproducibility

The step size of the focal power is limited by the resolution of the DAC of the current driver. For high precision applications a driver with 12 bits is recommended. As the relation between current and focal power is linear, the smallest step of e.g. the EL-10-30-C-VIS-LD is (12.5 dpt – 5 dpt) / 4096 = 0.0018 Dpt.

Unlike piezo systems, the EL-10-30 exhibits no hysteresis. The current through the coil induces a force, which is directly transferred onto the elastic membrane. There is no friction in the system. This means that at a constant temperature jumping between alternate current levels will always yield the same focal length. The effect of changes in temperature are described above. For the EL-10-30-Ci lenses, Optotune's Lens Driver 4 offers a focal power mode, which makes use of calibration data stored in the lens (EEPROM of the SE97B). The absolute reproducibility achieved over an operating temperature range of 10 to 50°C amounts to typically 0.1 diopters. More details on the focal power mode are provided in the Lens Driver manual.

Current control vs. voltage control

In principle, the EL-10-30 can be driven using a DC voltage (e.g. even a simple battery). However, as the lens incorporates an electromagnetic actuator, the force applied to the lens (and with that the focal distance) depends on the current flowing through the coil. As with all electronics, the resistance of the coil changes with temperature (12.5 Ohm at 25°C). So if a voltage controller is used, the focal distance may not be reproducible or drift away. This is especially the case at currents >200 mA where this effect can easily be in the range of 10%. Note that this temperature effect is visible in the order of seconds and has nothing to do with the expanding of the optical fluid described above, which is in the order of minutes.



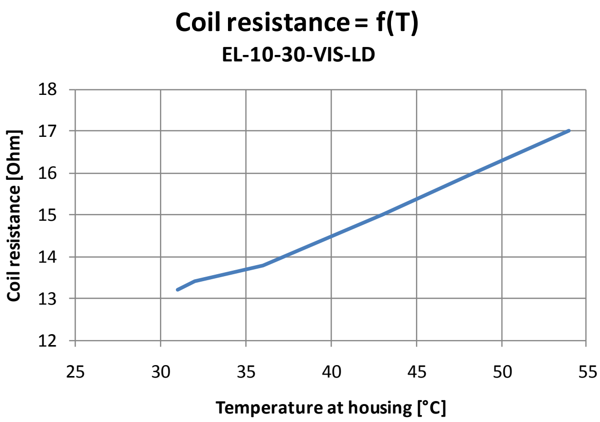


Figure 12: Coil resistance increases with temperature

Recommended drivers/power supplies

Optotune provides its own high-precision USB drivers with a resolution of 0.1 mA. It includes the I2C readout of the temperature sensor, which can be used for temperature compensation.

There are also many alternative off-the-shelf products available to control the EL-10-30:

- Precision constant current driver for laser diodes with external control via 0-5 V analog signal (e.g. Edmund Optics NT56-804 or NT84-355)
- For high precision applications (0.1 mA resolution) with manual control: TTi QL355
- For high precision applications (0.1 mA resolution) with USB/RS232 computer control: TTi QL355P
- For low precision applications (1 mA resolution) with manual control: TTi EL301R
- For low precision applications (1 mA resolution) with USB computer control: Quakko HY3005DP

The lens can also be driven using pulse width modulation (PWM) with a frequency between 20 kHz and 50 kHz. Another very useful component is the ADN8810 programmable precision current source of Analog Devices, which features 12 bits of resolution and can be controlled with an SPI interface.

Response time

The rise time on a current step is about 2.5 ms. However, it takes about 15 ms until the lens has fully settled. Figure 13 shows the optical response on a current step measured using the astigmatic lens approach with a cylinder lens and a quadrant diode[4]. The measurements were performed at room temperature.

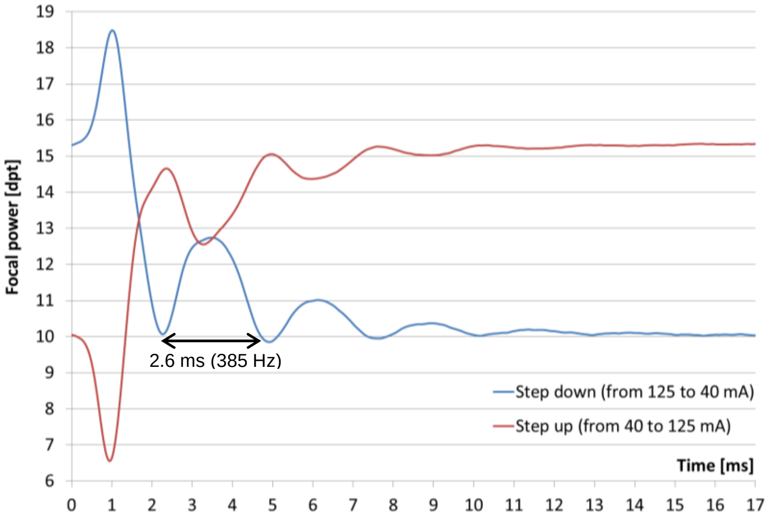


Figure 13: Typical optical response of the EL-10-30 to a current step from 40 to 125 mA and back.

This system is slightly over-damped and shows a resonant frequency at about 385 Hz. The latter can be very interesting if operation in resonance is desired. To achieve a shorter settling time, however, it is better to remove this frequency from the step function. Also, settling time can be improved by applying an overshooting step function. Tests show that the dynamics of the lens is similar in both directions and across different current ranges. With an optimized driving signal, the settling time is reduced below 5ms. Figure 14 shows an example of the response behavior with a driving signal filtered with three low-pass filters (300 Hz) in series. The following graph shows the optical response on a current step measured using two photodiodes at room temperature. For faster response times, please also consider the smaller electrical lens EL-6-18, which is about 50% faster.

[4] See Donald K. Cohen „Automatic focus control: The astigmatic lens approach", Applied Optics Vol. 23, No. 4, February 15, 1984

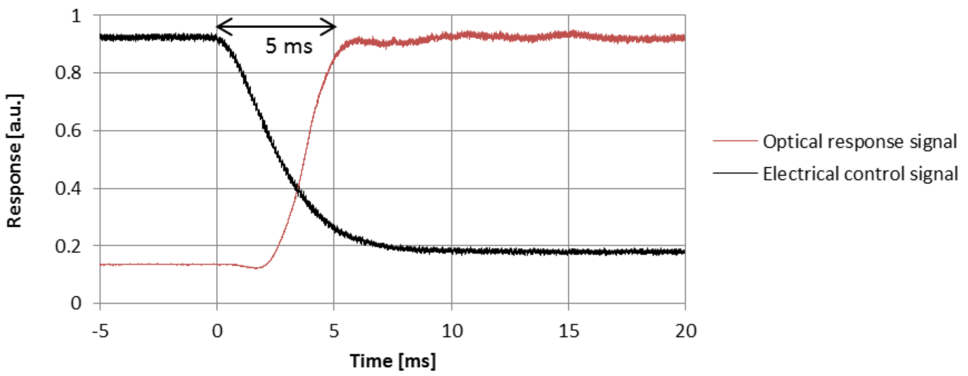


Figure 14: Optical response of the EL-10-30-C-LD-LP to a current step from 50 mA to 250 mA with a driving signal filtered with three low-pass filters (300 Hz) in series.

Atmospheric pressure and low temperature performance

By working principle, the atmospheric pressure has no influence on the lens. This has been validated down to values of 10^{-4} mbar. Furthermore, the EL-10-30 with LD material is suitable for low temperature operation. The lens is tunable down to temperatures as low as 230 K. The response time of the lens increases for lower temperatures (e.g. 3 s at 250 K and 60 s at 230 K). For temperatures below 220 K the lens freezes but no damage was observed in tests down to 10 K. The transmission of the lens is independent of the operating temperature.

Autofluorescence

The EL-10-30 with LD material is not auto fluorescent and can be used for fluorescence microscopy.

Life time

The EL-10-30 has passed relevant environmental and accelerated aging tests as outline in Table 2.

Test	EL-10-30
Mechanical cycling: 40 million full-range cycles (0 to 300 mA rectangular, at 10 Hz) 5 billion sinusoidal cycles at resonant frequency	Passed
High temperature test: 85±2°C; rel. hum. <6% for 168 hours, non-operational	Passed
Temperature cycling test: -40°C / +85°C for 30 min each, 3 min transition time, 100 cycles	Passed
Damp heat cycling test: 25°C / 55°C at 90-100% relative humidity, 3 hour transition time, 24h per cycle (9h plus transition time each), 18 cycles	Passed
Shock test: 800g for 1ms duration, 5 pulses in each direction (30 pulses in total)	Passed
Solar radiation test: 1120 W per m^2 (IEC 60068-2-5), 8 h irradiation & 16 h darkness, 10 cycles	Passed

Table 2: Environmental tests performed with the EL-10-30.

Mounting possibilities for the compact EL-10-30

G024503000, LI-NOS - Qioptiq

G061042000, LI-NOS - Qioptiq

KM200V/M, Thorlabs

NT57-977, Edmund Optics

NT64-564, Edmund Optics

NT03-676, Edmund Optics

Ordering information for custom versions of the EL-10-30

For custom versions, please use the following concept for part numbers:

EL-10-30-H-AR-MAT-APP- (F_{min}/F_{max})

H = Leave blank for compact housing
C: C-mount housing with FPC connector
Ci: Industrial C-mount housing with Hirose connector

AR = VIS: visible broad-band anti-reflection coating (400 – 700 nm)
NIR: near broad-band infrared anti-reflection coating (700 – 1100 nm)
1064: narrow-band anti-reflection coating at 1064 nm
NOC: No coating

MAT = HR: high refraction lens material (n_D = 1.559)
LD: low dispersion lens material (n_D = 1.300)

APP = MV: Machine vision option: Includes -150 mm offset lens for a total focal tuning range of -600 mm to infinity to +170 mm
LP: Laser processing option: Includes -150 mm offset lens and an optimized membrane for a total focal tuning range of -600 mm to infinity to +400 mm

f_{min}= minimum focal length

f_{max} = maximum focal length

Example: EL-10-30-VIS-LD-(+80/+300) refers to a custom electrical tunable lens of 10 mm aperture and 30 mm outer diameter (compact housing) with anti-reflection coating for visible light, low dispersion lens material and a focal tunable range from +80 to +300 mm.

Customization

Optotune's lens technology can be adapted to your needs. Table 3 provides a range of possible parameters.

Clear aperture (A)	From 2 mm to 55 mm
Range of focal length	From –A to infinity to +A
Response time	As little as 1 ms
Lens shapes	Spherical, from convex to flat to concave, whereby the other side of the lens may be a static free form Cylindrical shapes are possible as well
Cover glasses	BK7, fused silica, sapphire, plastics (PC, PMMA, COC)
Coatings	For cover glasses only

Table 3: Lens parameters that can be customized.

Note: Not all criteria can be met at once. For example, larger apertures based on the same EL-10-30 principle are slower and more power consuming. As an alternative, a mechanical design could be used similar to Optotune's ML-20-35 or ML-25-50, which requires no holding power and can easily be motorized.