



TCEL250 | DATASHEET

Telecentric lens for 2/3" detectors with integrated liquid lens, magnification 2.500x



SPECIFICATIONS

Optical specifications

Magnification		2.500
Magnification range		2.473 - 2.536
Image circle	(mm)	11.0
Max sensor size		2/3"
Working distance ²	(mm)	132.3
Workig distance range ³	(mm)	142.1 - 117.9
wF/N ⁴		20
Telecentricity typical (max) ⁵	(°)	< 0.08 (0.1)
Telecentricity max ⁶	(°)	< 0.4
Distortion typical (max) ⁷	(%)	< 0.05 (0.1)
Distortion max ⁶	(%)	< 0.1
Field depth ⁸	(mm)	0.2
Resolution max ⁹	(µm)	5

Liquid lens specifications

Liquid lens model		Optotune EL-16-40
Temperature sensor		Yes
Focal power mode		Yes
Repeatability using focal power mode	(dpt)	±0.05 small steps ±0.10 large steps
Response time ¹⁰	(ms)	5.0
Setting time ¹⁰	(ms)	25.0
Current range	(mA)	-500 to +500
Lifecycles (10%-90% sinusoidal)		>1,000,000,000
Connector		HR10A-7R-6PB

KEY ADVANTAGES

Extended depth of field

Thanks to the integration of Optotune[®] liquid lenses it is possible to significantly extend the DOF of telecentric optics

Excellent optical performances

The optical design of the lenses allows to obtain very low distortion and superior optical performances

Precise and quick autofocus

Electronically driven liquid lenses allow for extremely fast and precise changes of focus

Detailed test report with measured optical parameters.

TCEL series by Opto Engineering features a perfect combination of telecentric optics and liquid lenses technology allowing to significantly increase the depth of field (DOF).

Mechanical specifications

Mount		C
Phase adjustment ¹¹		Yes
Length ¹²	(mm)	157.0
Front diameter	(mm)	37.7
Mass	(g)	450

Environment

Operating temperature	(°C)	0-40
Storage temperature	(°C)	0-50
Operating relative humidity	(%)	20-85, non condensing

Installation Indoor use only

¹ Field of views are calculated at 0 dpt power of the liquid lens

² Working distance (nominal): distance between the front end of the mechanics and the object at 0 dpt power of the liquid lens

³ Minimum and maximum working distance are reported at a nominal range of the liquid lens; maximum excursion may be larger

⁴ working f/N : the real f/N of a lens in operating conditions.

⁵ Maximum angle between chief rays and optical axis on the object side. Typical (average production) values and maximum (guaranteed) values are listed.

⁶ Maximum values calculated in the range -2 to +3 dpt of the liquid lens

⁷ Percent deviation of the real image compared to an ideal, undistorted image. Typical (average production) values and maximum (guaranteed) values are listed.

⁸ At the borders of the field depth the image can be still used for measurement but, to get a very sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 3.45 µm.

⁹ Object side, calculated with the Rayleigh criterion with $\lambda = 520$ nm

¹⁰ Typical at 30°C, 0 ±250mA step.

¹¹ Indicates the availability of an integrated camera phase adjustment feature.

¹² Measured from the front end of the mechanics to the camera flange.

FIELD OF VIEW

Sensors ¹	(mm x mm)
1/3" (4.8 x 3.6 mm x mm)	1.92 x 1.44
1/2.5" (5.70 x 4.28 mm x mm)	2.28 x 1.71
1/2" (6.4 x 4.8 mm x mm)	2.56 x 1.92
1/1.8" (7.13 x 5.33 mm x mm)	2.85 x 2.13
2/3" (8.50 x 7.09 mm x mm)	3.40 x 2.84

ADDITIONAL NOTE

Performances guaranteed when used with vertical optical axis; when used with horizontal optical axis performances drop due to gravity induced aberrations of the liquid lens.

COMPATIBLE CONTROLLER

The TCEL tunable lens must be controlled by a suitable lens driver. Hirose cables and Liquid Lens driver are sold separately. Only the following part numbers are considered fully compatible with the TCEL series:

- **CBGPIO6PMF-3M**, 6 Pin Hirose Male - Female moulded connector cable, 3 m.
- **RT-EL-E-4i**, USB Controllers for liquid lens modules, industrial version.

COMPATIBLE PRODUCTS

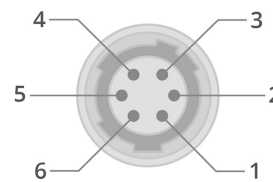
Full list of compatible products available [here](#).



A wide selection of innovative machine vision components.

MAGNIFICATION AND WORKING DISTANCE

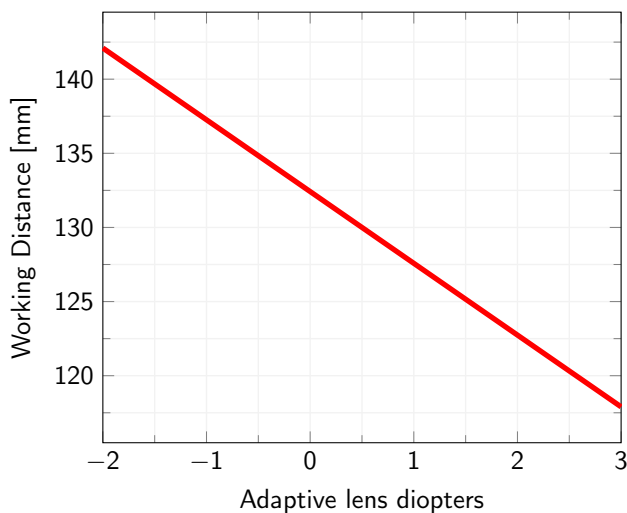
CONNECTOR PINOUT



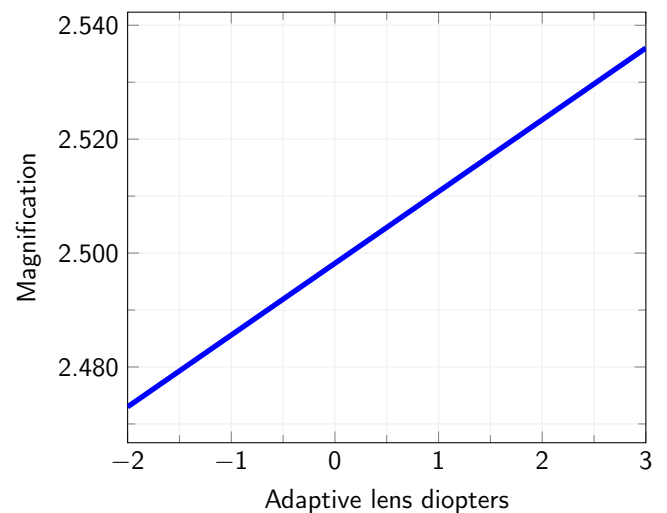
Device side

Pin	Description
1	Control current +
2	Control current -
3	GND
4	Power
5	I ² C SCL
6	I ² C SDA

Working distance

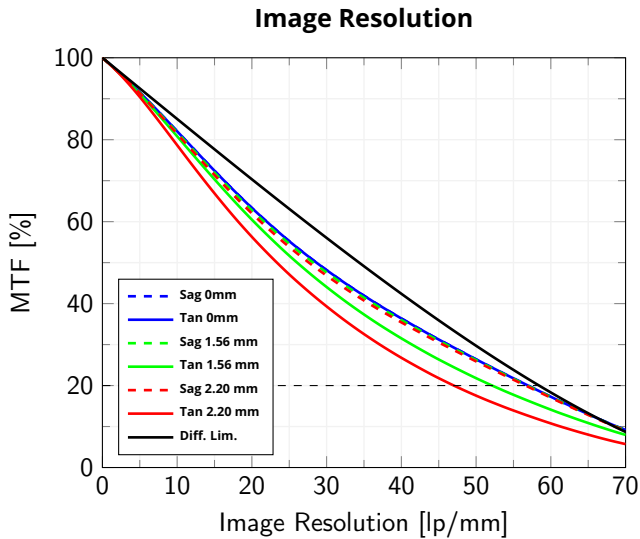


Magnification

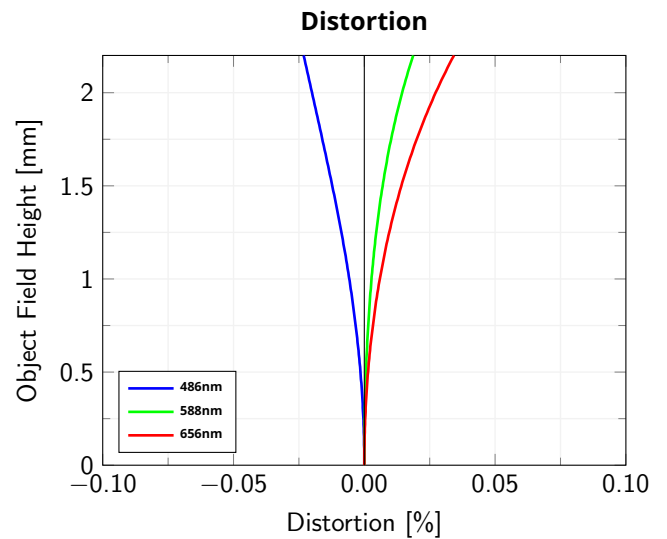


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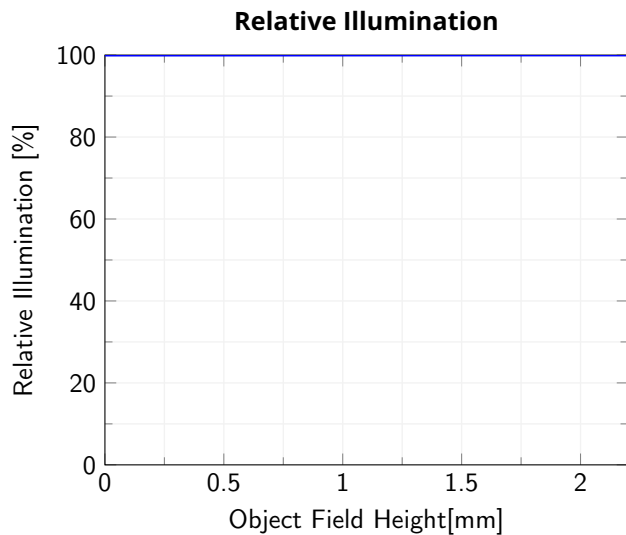
PERFORMANCE AT NOMINAL WORKING DISTANCE



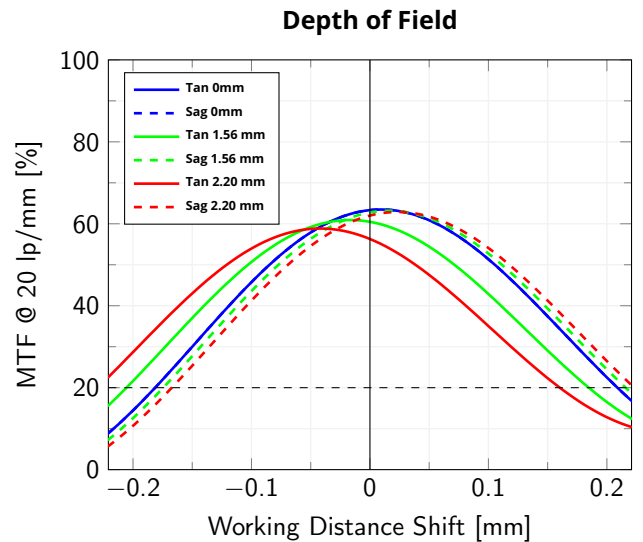
Modulation Transfer Function (MTF) vs. Image Resolution, wavelength range 486 nm - 656 nm



Object Field Height vs. Distortion, from the optical axis to the corner of the field of view



Relative illumination vs. Object Field Height, from the optical axis to the corner of the field of view



Modulation Transfer Function (MTF) @ 20 lp/mm vs. Working Distance Shift from the best focus Working Distance, wavelength range 486 nm - 656 nm

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