



OPTO ENGINEERING  
THE TELECENTRIC COMPANY



# *The* Opto Engineering catalog

2015

[www.opto-engineering.com](http://www.opto-engineering.com)

# Index

2015 catalog

## 4 Telecentric lenses

---

6	<b>TC series</b>	Bi-telecentric lenses for matrix detectors up to 2/3"
8	<b>TCLWD series</b>	Long working distance telecentric lenses for 2/3" detectors
10	<b>TCCX series</b>	Telecentric lenses for 2/3" detectors with built-in coaxial illumination
12	<b>TCCXQ series</b>	High resolution telecentric assembly with coaxial illumination
14	<b>TC2MHR-TC4MHR series</b>	High-resolution bi-telecentric lenses for large detectors up to 1.2"
16	<b>TC16M series</b>	Bi-telecentric lenses for 35 mm and 4 k / 8 k pixel line detectors
18	<b>TC4K series</b>	Flat telecentric lenses for 4 k pixel linescan cameras
20	<b>TC12K series</b>	Telecentric lenses for 12 k and 16 k pixel linescan cameras
22	<b>LTCLHP series</b>	Telecentric high-performance illuminators
24	<b>LTCL4K series</b>	Flat telecentric illuminators for linescan cameras
26	<b>TCBENCH series</b>	TC optical bench kits for easy measurements
27	<b>TCKIT CASE</b>	Telecentric optics selection for machine vision labs

## 28 Multi Mag optics

---

30	<b>TCDP series</b>	Double port bi-telecentric lens for detector up to 2/3"
32	<b>TCZR series</b>	8x bi-telecentric zoom lenses with motorized control
34	<b>MCZR series</b>	4x macro revolver with motorized control

## 36 360° view optics

---

38	<b>PC series</b>	Pericentric lenses for 360° top and lateral view with just one camera
42	<b>PCCD series</b>	Catadioptric lenses for 360° top and lateral view with just one camera
44	<b>PCHI series</b>	Hole inspection optics for 360° inside view in perfect focus
46	<b>PCBP series</b>	Boroscopic probes for panoramic cavity imaging and measurement from inside
48	<b>PCPW series</b>	Polyview optics for multiple side views with one shot
50	<b>PCMP series</b>	Micro-polyview optics for 3D measurement and imaging of small parts
52	<b>TCCAGE series</b>	Bi-telecentric system for multiple side imaging and measurement at 90°

## 54 Macro lenses

---

56	<b>MC series</b>	Zero distortion macro lenses
58	<b>MC3-03X macro</b>	Zero distortion multi-configuration macro lens
60	<b>MC4K series</b>	Macro lenses for 4 k pixel linescan cameras
62	<b>MC12K series</b>	Macro lenses for 12 k and 16 k pixel linescan cameras

## 64 3D optics

---

66	MCSM1-01X	Macro lens with Scheimpflug adjustment
68	TCSM series	3D bi-telecentric lenses with Scheimpflug adjustment
70	LTPRSMHP3W series	High-performance 3D LED pattern projectors
74	LTPRHP3W series	High-performance LED pattern projectors
78	LTPRXP series	High-power LED pattern projectors

## 82 Infrared optics

---

83	SWIR series	Short-wave infrared lenses
84	MWIR series	Medium-wave infrared lenses
85	LWIR series	Long-wave infrared lenses

## 86 Illuminators

---

88	LTRN series	LED ring illuminators
90	LTBC series	LED Backlight illuminators
92	LTDM series	Diffusive strobed dome illuminators
94	LTLA series	Diffusive strobed low angle ring light illuminators
96	LTDMLA series	Diffusive strobed dome + low angle illumination systems
98	View-through system	Space saving illumination system for double-side object inspection
100	LTDV series	Strobe controllers

## 102 Accessories

---

104	CMBS series	45° beam splitter
106	CMMR series	45° first surface mirrors
110	WI series	Protective windows
112	CMHO series	Clamping mechanics
114	CMPT series	Mounting plates
114	CMPH series	Pattern holders
115	PT series	Patterns
118	Optical filters	Lens filters and mounting accessory
120	Glossary	

# Outstanding optical performance. Unmatched customer service.

Opto Engineering Telecentric lenses represents our core business: these products benefit from a decade-long effort in progressive research & development, resulting in an extensive range of part numbers for a diverse and ever-growing number of applications.

## **These products achieve the highest optical performances available on the market:**

- extra-telecentricity for thick object imaging
- very low distortion for accurate measurements
- excellent resolution for small pixel cameras
- wide field depth for large object displacements
- pre-adjusted back focal length and working distance
- compact and robust design, tailored for industrial environments

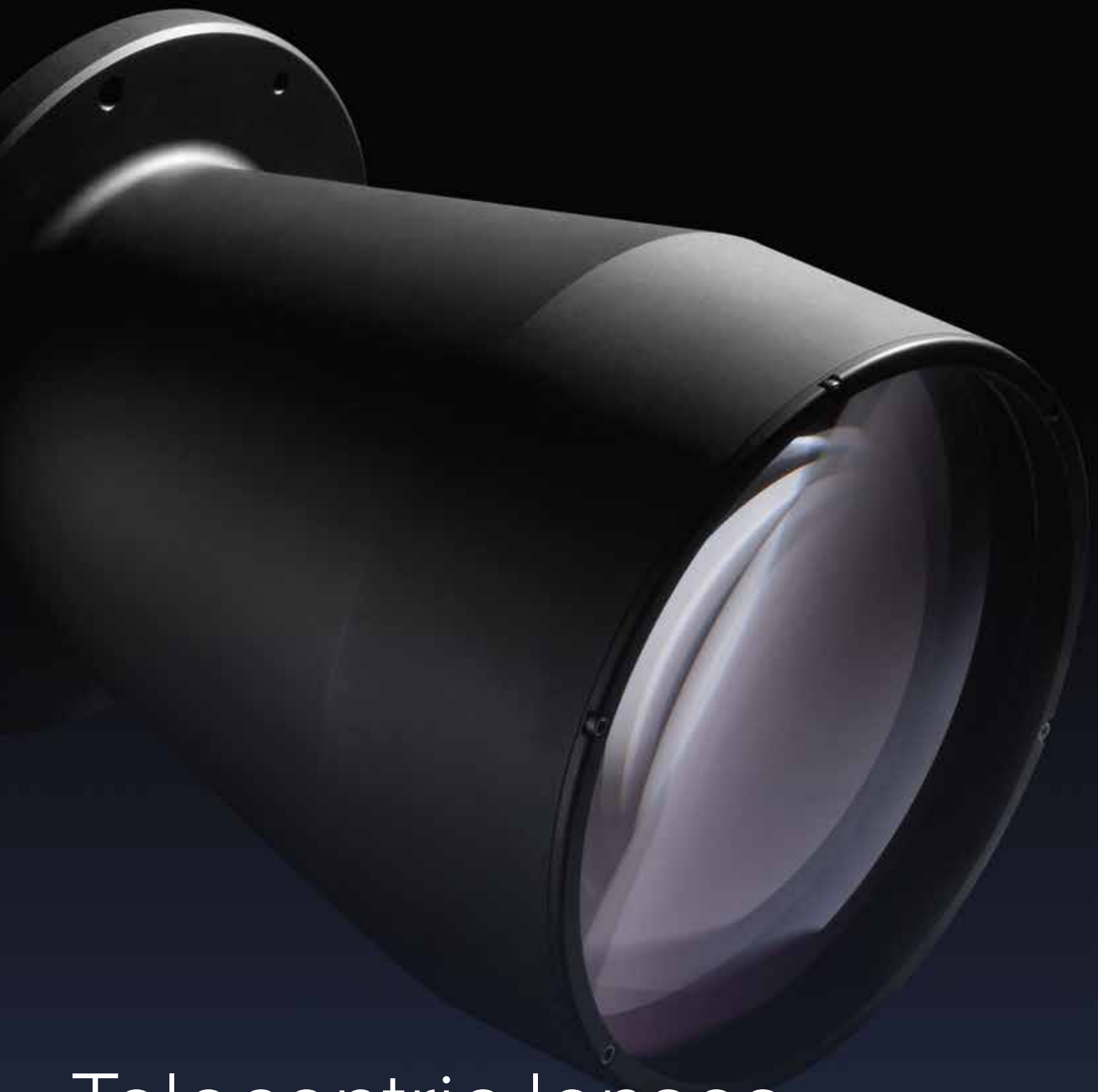
## **TC lenses for matrix detectors also feature:**

- bi-telecentric design
- detailed test report for each lens

*Opto Engineering testing procedures have been validated by TÜV Rheinland*



Refer to specific datasheets available at [www.opto-engineering.com](http://www.opto-engineering.com) for product compliancy with regulations, certifications and safety labels.



# Telecentric lenses



# TC series

Bi-telecentric lenses for matrix detectors up to 2/3"



**TC series bi-telecentric lenses** represent the key component of any measurement system powered by machine vision: these lenses can truly take advantage of high-resolution detectors such as 5 Mpx - 2/3", acquiring images with exceptional fidelity and precision.

Opto Engineering bi-telecentric design allows these optics to achieve pure telecentricity: no magnification change occurs when moving away or towards the subject, making TC series ideal for measurement applications of mechanical parts ranging from extruded aluminium profiles to tiny clock gears.

No other lenses can offer the same optical performances in terms of telecentricity and absence of distortion: additionally you can further enhance depth of field and optical accuracy by pairing our TC lenses with LTCLHP telecentric illuminators.

All of our TC lenses are rigorously tested and supplied with a detailed Test Report: We guarantee that 100% of our TC lenses meet or exceed our written specifications.

Opto Engineering TC series offers the best performance to price ratio available today and is the ideal choice when no compromise can be accepted in terms of reliability and ease of use.

Additionally we supply useful accessories including CMHO clamping mechanics and CMPT mounting plates: mechanical support systems for easy integration in industrial environments, where a solid and secure assembly is mandatory.

## KEY ADVANTAGES

**High telecentricity** for thick object imaging.

**Nearly zero distortion** for accurate measurements.

**Excellent resolution** for high resolution cameras.

**Simple and robust design** for industrial environments.

**Easy filter insertion.**

Detailed **test report** with **measured** optical parameters.



Opto Engineering testing procedures have been validated by TÜV Rheinland.

## DO YOU KNOW?

Opto Engineering provides fully localized documentation of the complete product range, with schematics and in-depth specifications. Available for download at:

[www.opto-engineering.com](http://www.opto-engineering.com)



Part number	Mag. (x)	Image circle Ø (mm)	Detector type					Optical specifications						Dimensions				
			1/3"	1/2.5"	1/2"	1/1.8"	2/3" - 5 Mpx	WD	wF/#	Telecentricity	Distortion	Field	CTF	Mount	Length	Diam.		
			w x h	w x h	w x h	w x h	w x h	(mm)		typical (max)	typical (max)	depth	@70lp/mm		(mm)	(mm)		
			4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.37	8.45 x 7.07											
			(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)											
			Object field of view (mm x mm) 8															
TC 23 004	2.000	11.0	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.56 x 2.68	4.22 x 3.55	56.0	11	< 0.08 (0.10)	< 0.04 (0.08)	0.23	> 30	C	101.4	28		
TC 23 007	1.333	11.0	3.60 x 2.70	4.28 x 3.21	4.80 x 3.60	5.35 x 4.03	6.34 x 5.30	60.1	11	< 0.08 (0.10)	< 0.03 (0.08)	0.5	> 30	C	78.5	28		
TC 23 009	1.000	11.0	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.37	8.44 x 7.06	62.2	11	< 0.08 (0.10)	< 0.04 (0.08)	0.9	> 25	C	65.0	28		
TC 23 012	0.735	11.0	6.54 x 4.90	7.77 x 5.82	8.72 x 6.54	9.71 x 7.31	11.5 x 9.62	53.9	14	< 0.04 (0.10)	< 0.04 (0.10)	1.2	> 25	C	60.3	28		
TC 12 016	0.385	8.0	12.5 x 9.36	14.8 x 11.1	16.6 x 12.5	18.5 x 14.0	Ø = 18.4	43.1	8	< 0.04 (0.10)	< 0.04 (0.08)	5	> 40	C	93.0	37.7		
TC 23 016	0.528	11.0	9.09 x 6.82	10.8 x 8.10	12.1 x 9.09	13.5 x 10.2	16.0 x 13.4	43.1	8	< 0.06 (0.10)	< 0.04 (0.07)	2	> 30	C	112.7	37.7		
TC 12 024	0.255	8.0	18.8 x 14.1	22.4 x 16.8	25.1 x 18.8	28.0 x 21.1	Ø = 27.7	67.2	8	< 0.08 (0.10)	< 0.04 (0.08)	10	> 45	C	117.8	44		
TC 23 024	0.350	11.0	13.7 x 10.3	16.3 x 12.2	18.3 x 13.7	20.4 x 15.3	24.1 x 20.2	67.2	8	< 0.08 (0.10)	< 0.04 (0.10)	5	> 45	C	137.5	44		
TC 13 036	0.133	6.0	36.0 x 27.0	Ø = 32.0	Ø = 36.0	Ø = 40.2	n.a.	102.5	8	< 0.04 (0.08)	< 0.03 (0.08)	38	> 50	C	133.0	61		
TC 12 036	0.177	8.0	27.1 x 20.3	32.2 x 24.1	36.1 x 27.1	40.2 x 30.3	Ø = 39.9	102.5	8	< 0.03 (0.08)	< 0.04 (0.10)	21	> 40	C	145.2	61		
TC 23 036	0.243	11.0	19.7 x 14.8	23.4 x 17.6	26.3 x 19.7	29.3 x 22.1	34.7 x 29.0	102.5	8	< 0.04 (0.08)	< 0.04 (0.10)	11	> 40	C	164.9	61		
TC 13 048	0.098	6.0	48.8 x 36.6	Ø = 43.5	Ø = 48.8	Ø = 54.6	n.a.	133.4	8	< 0.08 (0.10)	< 0.06 (0.10)	65	> 40	C	167.9	75		
TC 12 048	0.134	8.0	35.9 x 26.9	42.5 x 31.9	47.8 x 35.9	53.3 x 40.1	Ø = 52.8	132.9	8	< 0.07 (0.10)	< 0.06 (0.10)	37	> 40	C	181.5	75		
TC 23 048	0.184	11.0	26.1 x 19.6	31.0 x 23.3	34.8 x 26.1	38.8 x 29.2	46.0 x 38.4	132.9	8	< 0.08 (0.10)	< 0.05 (0.10)	20	> 40	C	201.0	75		
TC 12 056	0.114	8.0	42.0 x 31.5	49.9 x 37.4	56.0 x 42.0	62.3 x 46.9	Ø = 61.8	157.8	8	< 0.04 (0.08)	< 0.04 (0.08)	51	> 50	C	205.0	80		
TC 23 056	0.157	11.0	30.6 x 22.9	36.3 x 27.2	40.7 x 30.6	45.4 x 34.2	53.8 x 45.0	157.8	8	< 0.05 (0.08)	< 0.03 (0.08)	27	> 45	C	225.0	80		
TC 13 064	0.074	6.0	65.2 x 48.9	Ø = 58.1	Ø = 65.2	Ø = 72.9	n.a.	181.9	8	< 0.06 (0.08)	< 0.03 (0.07)	124	> 40	C	212.3	100		
TC 12 064	0.100	8.0	48.0 x 36.0	57.0 x 42.7	64.0 x 48.0	71.2 x 53.6	Ø = 70.6	181.8	8	< 0.05 (0.08)	< 0.04 (0.07)	67	> 50	C	225.9	100		
TC 23 064	0.138	11.0	34.9 x 26.2	41.5 x 31.1	46.6 x 34.9	51.9 x 39.0	61.4 x 51.4	181.8	8	< 0.05 (0.08)	< 0.03 (0.07)	35	> 50	C	245.5	100		
TC 23 072	0.122	11.0	39.2 x 29.4	46.6 x 35.0	52.3 x 39.2	58.3 x 43.9	69.1 x 57.8	226.7	8	< 0.04 (0.08)	< 0.03 (0.07)	45	> 40	C	299.2	116		
TC 13 080	0.059	6.0	81.2 x 60.9	Ø = 72.4	Ø = 81.2	Ø = 90.9	n.a.	225.9	8	< 0.05 (0.08)	< 0.03 (0.08)	192	> 40	C	259.2	116		
TC 12 080	0.080	8.0	59.8 x 44.8	71.0 x 53.2	79.7 x 59.8	88.7 x 66.8	Ø = 88.0	226.7	8	< 0.03 (0.08)	< 0.04 (0.10)	104	> 50	C	271.5	116		
TC 23 080	0.110	11.0	43.5 x 32.6	51.7 x 38.8	58.0 x 43.5	64.6 x 48.7	76.5 x 64.0	226.7	8	< 0.04 (0.08)	< 0.02 (0.10)	55	> 50	C	291.2	116		
TC 23 085	0.104	11.0	46.3 x 34.8	55.1 x 41.3	61.8 x 46.3	68.8 x 51.8	81.5 x 68.2	279.7	8	< 0.04 (0.08)	< 0.02 (0.08)	62	> 45	C	344.5	143		
TC 13 096	0.050	6.0	96.0 x 72.0	Ø = 85.5	Ø = 96.0	Ø = 107.4	n.a.	279.6	8	< 0.06 (0.08)	< 0.04 (0.10)	268	> 50	C	303.3	143		
TC 12 096	0.068	8.0	70.6 x 52.9	83.8 x 62.9	94.1 x 70.6	104.8 x 78.9	Ø = 103.9	278.6	8	< 0.06 (0.08)	< 0.03 (0.08)	145	> 45	C	317.0	143		
TC 23 096	0.093	11.0	51.4 x 38.5	61.0 x 45.8	68.5 x 51.4	76.3 x 57.5	90.4 x 75.6	278.6	8	< 0.06 (0.08)	< 0.04 (0.08)	77	> 40	C	336.6	143		
TC 23 110	0.079	11.0	60.5 x 45.4	71.8 x 53.9	80.6 x 60.5	89.8 x 67.6	106.4 x 89.0	334.5	8	< 0.06 (0.08)	< 0.03 (0.07)	106	> 40	C	430.4	180		
TC 12 120	0.052	8.0	92.1 x 69.1	109.4 x 82.0	122.8 x 92.1	136.7 x 103.0	Ø = 135.5	334.5	8	< 0.06 (0.08)	< 0.04 (0.10)	247	> 45	C	402.7	180		
TC 23 120	0.072	11.0	67.0 x 50.3	79.6 x 59.7	89.4 x 67.0	99.5 x 75.0	117.9 x 98.7	334.5	8	< 0.07 (0.08)	< 0.04 (0.10)	131	> 35	C	422.4	180		
TC 23 130	0.068	11.0	70.9 x 53.2	84.2 x 63.2	94.5 x 70.9	105.3 x 79.3	124.7 x 104.3	396.0	8	< 0.05 (0.08)	< 0.04 (0.10)	146	> 40	C	490.0	200		
TC 12 144	0.044	8.0	107.9 x 80.9	128.2 x 96.2	143.9 x 107.9	160.3 x 120.7	Ø = 158.9	396.0	8	< 0.05 (0.08)	< 0.05 (0.08)	339	> 35	C	462.1	200		
TC 23 144	0.061	11.0	78.6 x 58.9	93.3 x 70.0	104.8 x 78.6	116.7 x 87.9	138.3 x 115.7	396.0	8	< 0.05 (0.08)	< 0.04 (0.08)	180	> 40	C	481.9	200		
TC 23 172	0.051	11.0	94.6 x 71.0	112.4 x 84.3	126.1 x 94.6	140.5 x 105.8	166.5 x 139.3	526.9	8	< 0.05 (0.08)	< 0.04 (0.10)	260	> 40	C	630.3	260		
TC 12 192	0.033	8.0	144.1 x 108.0	171.1 x 128.3	192.1 x 144.1	213.9 x 161.1	Ø = 212.0	526.9	8	< 0.06 (0.08)	< 0.04 (0.08)	603	> 45	C	602.6	260		
TC 23 192	0.046	11.0	104.9 x 78.6	124.6 x 93.4	139.8 x 104.9	155.7 x 117.3	184.5 x 154.4	526.9	8	< 0.06 (0.08)	< 0.05 (0.08)	320	> 35	C	622.3	260		
TC 23 200	0.044	11.0	110.0 x 82.5	130.7 x 98.0	146.7 x 110.0	163.3 x 123.0	193.5 x 161.9	492.8	8	< 0.06 (0.08)	< 0.05 (0.10)	352	> 40	C	792.0	322		
TC 23 240	0.037	11.0	130.8 x 98.1	155.4 x 116.6	174.4 x 130.8	194.3 x 146.3	230.2 x 192.6	492.8	8	< 0.03 (0.08)	< 0.04 (0.08)	498	> 45	C	775.1	322		

- Working distance: distance between the front end of the mechanics and the object. Set this distance within +/- 3% of the nominal value for maximum resolution and minimum distortion.
- Working F-number (wF/#): the real F-number of a lens when used as a macro. Lenses with smaller apertures can be supplied on request.
- Maximum slope of chief rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement. Typical (average production) values and maximum (guaranteed) values are listed.
- Percent deviation of the real image compared to an ideal, undistorted image: typical (average production) values and maximum (guaranteed) values are listed.
- At the borders of the field depth the image can be still used for measurement but, to get a perfectly sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 5.5 µm.
- Measured from the front end of the mechanics to the camera flange.
- With 1/1.8" (9 mm diagonal) detectors, the FOV of TC 12 yyy lenses may show some vignetting at the image corners, as these lenses are optimized for 1/2" detectors (8 mm diagonal).
- For the fields with the indication "Ø =", the image of a circular object of such diameter is fully inscribed into the detector.

### Ordering information

It's easy to select the right lens for your application: our part numbers are coded as **TC xx yyy**, where **xx** defines the camera sensor size (13 = 1/3", 12 = 1/2", 23 = 2/3") and **yyy** refers to the width dimension of the object field of view (FOV), in millimeters. For instance, a TC 12 064 features a field of view of 64 (x 48) mm with a 1/2" camera sensor.

# TCLWD series

Long working distance telecentric lenses for 2/3" detectors

**NEW**



**TCLWD** is a range of telecentric lenses specifically designed for electronic and semiconductor Automated Optical Inspection (AOI) and tool pre-setting machines.

All these lenses feature a working distance of 135 mm while ensuring excellent optical resolution, high telecentricity and low distortion, thus matching and even exceeding the industrial requirements for the target applications.

The long working distance allows for extra space, which is essential if you need to install illumination, pick-up tools or provide the necessary separation from hazardous production processes.

In addition to the long working distance, TCLWD optics deliver a numerical aperture large enough to take advantage of high resolution / small pixel size cameras, making these lenses a perfect match for general-purpose 2D measurement systems.

## KEY ADVANTAGES

### Long working distance

Perfect for electronic components inspection and tool pre-setting machines.

### High numerical aperture

For small pixel size / high resolution detectors.

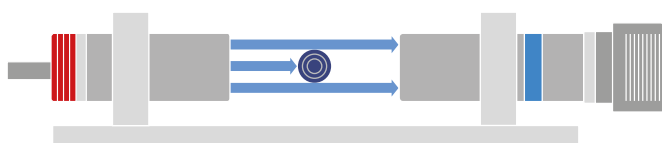
### Easy rotational phase adjustment

Robust and precise tuning of the lens-camera phase.

### Full range of compatible products

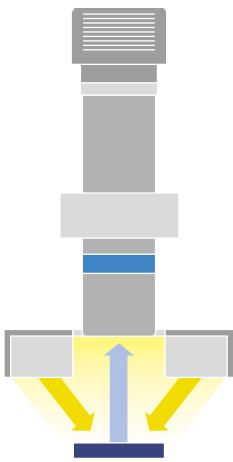
Fits LTCLHP telecentric illuminators, CMHO clamping supports and LTRN ring illuminators.

## Application examples

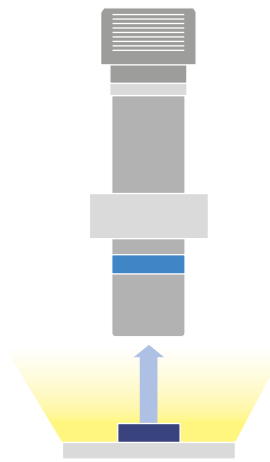
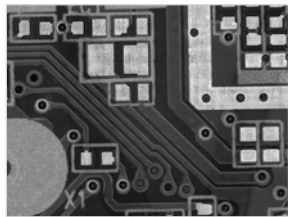


A TCLWD050 lens assembled with a CMHO016 clamping mechanics and back-illuminated by a LTCLHP016-G telecentric illuminator forming an inspection system for measurement of mechanical components such as milling tools and screws.





A TCLWD lens in combination with LTRN016 ring illuminator inspecting an electronic board.



A TCLWD lens measuring a clock gear with back-light illumination.



Part number	Mag. (x)	Image circle Ø (mm)	Detector type					Optical specifications					Dimensions			
			1/3"	1/2.5"	1/2"	1/1.8"	2/3" - 5 Mpx	WD	wF/#	Telecentricity	Distortion	Field depth	CTF	Mount	Length	Diam.
			w x h	w x h	w x h	w x h	w x h	(mm)		typical (max)	typical (max)	(mm)	@35lp/mm		(mm)	(mm)
			Object field of view (mm x mm)													
TCLWD 050	0.50	11.0	9.60 x 7.20	11.4 x 8.56	12.8 x 9.60	14.3 x 10.7	16.9 x 14.1	132.3	12	0.04 (0.06)	0.1 (0.20)	4	> 60	C	130.7	37.7
TCLWD 066	0.66	11.0	7.27 x 5.45	8.64 x 6.48	9.70 x 7.27	10.8 x 8.14	12.8 x 10.7	132.3	12	0.04 (0.06)	0.1 (0.20)	2.3	> 58	C	149.3	37.7
TCLWD 075	0.75	11.0	6.40 x 4.80	7.60 x 5.71	8.53 x 6.40	9.51 x 7.16	11.3 x 9.43	132.3	12	0.04 (0.06)	0.1 (0.20)	1.8	> 55	C	155.0	37.7
TCLWD 100	1.00	11.0	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.37	8.45 x 7.07	132.3	12	0.04 (0.06)	0.05 (0.10)	1	> 60	C	126.0	37.7
TCLWD 150	1.50	11.0	3.20 x 2.40	3.80 x 2.85	4.27 x 3.20	4.75 x 3.58	5.63 x 4.71	132.3	16	0.04 (0.06)	0.05 (0.10)	0.6	> 50	C	140.4	37.7
TCLWD 250	2.50	11.0	1.92 x 1.44	2.28 x 1.71	2.56 x 1.92	2.85 x 2.15	3.38 x 2.83	132.3	20	0.04 (0.06)	0.05 (0.10)	0.3	> 40	C	157.0	37.7
TCLWD 350	3.50	11.0	1.37 x 1.03	1.63 x 1.22	1.83 x 1.37	2.04 x 1.53	2.41 x 2.02	132.3	24	0.04 (0.06)	0.05 (0.10)	0.2	> 30	C	174.7	37.7

- Working distance: distance between the front end of the mechanics and the object. Set this distance within +/- 3% of the nominal value for maximum resolution and minimum distortion.
- Working F-number (wF/#): the real F-number of a lens when used as a macro. Lenses with smaller apertures can be supplied on request.
- Maximum slope of chief rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement. Typical (average production) values and maximum (guaranteed) values are listed.
- Percent deviation of the real image compared to an ideal, undistorted image: typical (average production) values and maximum (guaranteed) values are listed.
- At the borders of the field depth the image can be still used for measurement but, to get a perfectly sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 5.5 µm.
- Measured from the front end of the mechanics to the camera flange.

#### Ordering information

It's easy to select the right lens for your application: our part numbers are coded as **TCLWD xxx**, where **xxx** defines the magnification (050 = 0.50, 066 = 0.66, 075 = 0.75, ...). For instance, a TCLWD 050 features a 0.50 magnification.

# TCCX series

Telecentric lenses for 2/3" detectors with built-in coaxial illumination

**NEW**



**TCCX series** is a range of lenses designed for flat surface measurement and defect inspections that offers the same magnifications and working distance of TCLWD series while adding integrated coaxial light.

Such lighting configuration is required to homogeneously illuminate uneven surfaces and detecting small surface defects such as scratches or grooves, finding application in many industries: from electronic and semiconductor to glass and mechanics.

All these lenses operate at a working distance of 135 mm while their large numerical aperture enables the superior resolution needed for small pixel cameras, matching and even exceeding the industrial requirements of on- and off-line applications.

The built-in LED source, equipped with advanced electronics, provides excellent illumination stability and homogeneity, key factors for the reliability of any machine vision system. The unique optical design minimizes the back-reflection issues of conventional coaxial illumination systems: this makes TCCX the perfect choice especially when highly reflective flat surfaces (approx. > 30% reflectance) are involved.

Application examples include recognition of silicon wafers pattern and inspection of LCD displays, polished metal surfaces, plastic and glass panels, and many other.

## KEY ADVANTAGES

### Large numerical aperture

For small pixel size camera resolution.

### Long working distance

Tailored for electronic components inspection.

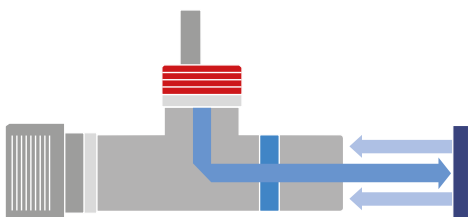
### Compact built-in illumination

Ideal for high-end applications in semiconductor industry.

### Easy rotational phase adjustment

Robust and precise tuning of the camera phase.

## Application examples



TCCX lens clamped inspecting objects with coaxial illumination.

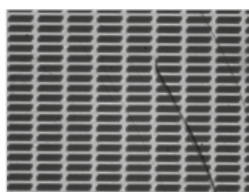
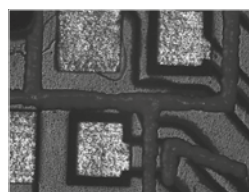


Image of an LCD display taken with a TCCX250 lens.



Details of an electronic board imaged with a TCCX lens with green illumination.



Scratches on a stainless steel surface emphasized by coaxial illumination.



### Precise light intensity tuning

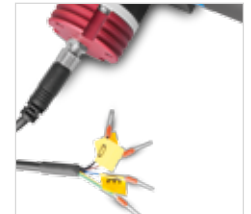
Easily and precisely tune the light intensity level thanks to the leadscrew multi-turn trimmer positioned in the back.



### Direct LED control

The built-in electronics can be bypassed in order to drive the LED directly for use in continuous or pulsed mode.

When bypassed, built-in electronics behave as an open circuit allowing direct control of the LED source.



## Electrical specifications

Part number	Light	Device power ratings				LED power ratings			
		Light color, wavelength peak	DC voltage		Power consumption	Max LED fwd current	Forward voltage		Max pulse current
			min (V)	max (V)			typ. (V)	max (V)	
TCCX xxx-G	green, 520 nm	12	24	< 2.5	350	3.3	4.00	2000	
TCCX xxx-W	white	12	24	< 2.5	350	2.78	n.a.	2000	

1 Used in continuous (not pulsed) mode.

2 At max forward current. Tolerance is ±0.06V on forward voltage measurements.

3 At pulse width ≤ 10 ms, duty cycle ≤ 10% condition.

Built-in electronics board must be bypassed (see tech info online).

Part number	Mag. (x)	Image circle Ø (mm)	Detector type					Optical specifications					Dimensions			
			1/3"	1/2.5"	1/2"	1/1.8"	2/3" - 5 Mpx	WD	wF/#	Telecentricity	Distortion	Field depth	CTF	Mount	Length	Diam.
			w x h	w x h	w x h	w x h	w x h	(mm)		typical (max)	typical (max)	(mm)	@35lp/mm		(mm)	(mm)
<b>Object field of view (mm x mm)</b>																
TCCX 050-G	0.50	11	9.60 x 7.20	11.4 x 8.56	12.8 x 9.60	14.3 x 10.7	16.9 x 14.1	132.3	12	0.04 (0.06)	0.1 (0.20)	4	> 60	C	131.2	37.7
TCCX 050-W	0.50	11	9.60 x 7.20	11.4 x 8.56	12.8 x 9.60	14.3 x 10.7	16.9 x 14.1	132.3	12	0.04 (0.06)	0.1 (0.20)	4	> 60	C	131.2	37.7
TCCX 066-G	0.66	11	7.27 x 5.45	8.64 x 6.48	9.70 x 7.27	10.8 x 8.14	12.8 x 10.7	132.3	12	0.04 (0.06)	0.1 (0.20)	2.3	> 58	C	149.8	37.7
TCCX 066-W	0.66	11	7.27 x 5.45	8.64 x 6.48	9.70 x 7.27	10.8 x 8.14	12.8 x 10.7	132.3	12	0.04 (0.06)	0.1 (0.20)	2.3	> 58	C	149.8	37.7
TCCX 075-G	0.75	11	6.40 x 4.80	7.60 x 5.71	8.53 x 6.40	9.51 x 7.16	11.3 x 9.43	132.3	12	0.04 (0.06)	0.1 (0.20)	1.8	> 55	C	155.5	37.7
TCCX 075-W	0.75	11	6.40 x 4.80	7.60 x 5.71	8.53 x 6.40	9.51 x 7.16	11.3 x 9.43	132.3	12	0.04 (0.06)	0.1 (0.20)	1.8	> 55	C	155.5	37.7
TCCX 100-G	1.00	11	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.37	8.45 x 7.07	132.3	12	0.04 (0.06)	0.05 (0.10)	1	> 60	C	132.9	37.7
TCCX 100-W	1.00	11	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.37	8.45 x 7.07	132.3	12	0.04 (0.06)	0.05 (0.10)	1	> 60	C	132.9	37.7
TCCX 150-G	1.50	11	3.20 x 2.40	3.80 x 2.85	4.27 x 3.20	4.75 x 3.58	5.63 x 4.71	132.3	16	0.04 (0.06)	0.05 (0.10)	0.6	> 50	C	147.2	37.7
TCCX 150-W	1.50	11	3.20 x 2.40	3.80 x 2.85	4.27 x 3.20	4.75 x 3.58	5.63 x 4.71	132.3	16	0.04 (0.06)	0.05 (0.10)	0.6	> 50	C	147.2	37.7
TCCX 250-G	2.50	11	1.92 x 1.44	2.28 x 1.71	2.56 x 1.92	2.85 x 2.15	3.38 x 2.83	132.3	20	0.04 (0.06)	0.05 (0.10)	0.3	> 40	C	163.9	37.7
TCCX 250-W	2.50	11	1.92 x 1.44	2.28 x 1.71	2.56 x 1.92	2.85 x 2.15	3.38 x 2.83	132.3	20	0.04 (0.06)	0.05 (0.10)	0.3	> 40	C	163.9	37.7
TCCX 350-G	3.50	11	1.37 x 1.03	1.63 x 1.22	1.83 x 1.37	2.04 x 1.53	2.41 x 2.02	132.3	24	0.04 (0.06)	0.05 (0.10)	0.2	> 30	C	181.5	37.7
TCCX 350-W	3.50	11	1.37 x 1.03	1.63 x 1.22	1.83 x 1.37	2.04 x 1.53	2.41 x 2.02	132.3	24	0.04 (0.06)	0.05 (0.10)	0.2	> 30	C	181.5	37.7

1 Working distance: distance between the front end of the mechanics and the object.

Set this distance within +/- 3% of the nominal value for maximum resolution and minimum distortion.

2 Working F-number (wF/#): the real F-number of a lens when used as a macro. Lenses with smaller apertures can be supplied on request.

3 Maximum slope of chief rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement. Typical (average production) values and maximum (guaranteed) values are listed.

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

5 At the borders of the field depth the image can be still used for measurement but, to get a perfectly sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 5.5 µm.

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

### Ordering information

It's easy to select the right lens for your application: our part numbers are coded as TCCX xxx-y, where xxx defines the magnification (050 = 0.50, 066 = 0.66, 075 = 0.75, ...) and y defines the source color ("G" stands for "green light", "W" stands for "white light"). For instance, a TCCX 050-G features a 0.50 magnification with a green light source.

# TCCXQ series

High resolution telecentric assembly with coaxial illumination

**NEW**



**TCCXQ optical assemblies** integrate the high optical performances of TC telecentric lenses and the LTCLHP series ability to provide accurate and reliable illumination.

Pairing these two Opto Engineering flagship products results in a system completely free from straylights and back-reflections, while marking superior optical performances (in terms of resolution, telecentricity and distortion) even at the highest magnifications.

This optical layout also minimizes the overall height of the system, while the placement of the camera port allows for easy phase and back-focal adjustments.

TCCXQ assemblies can successfully employed in high accuracy measurement applications as well as Automated Optical Inspection (AOI) setups.

## KEY ADVANTAGES

### Completely stray-light free

Compatible with both reflective and diffusive surface objects imaging.

### High resolution

For sharp edge imaging and small imperfections detection.

### Bi-telecentric design

Same degree of measurement accuracy as standard bi-telecentric lenses.

### Optimal light collimation

For precise direct light measurement applications.



TCCXQ 066-G, formed by TCLWD 066, CMBS 016, LTCLHP 016-G.

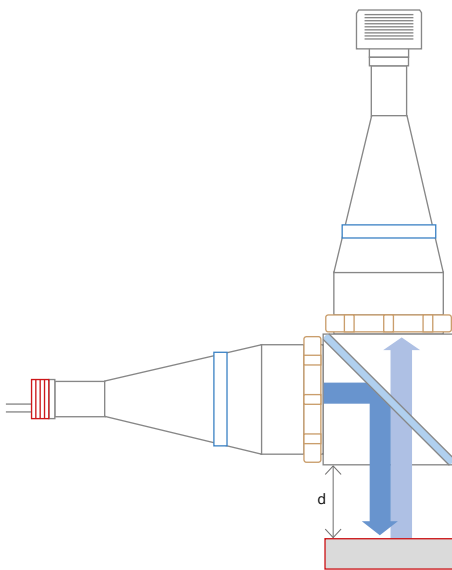


## Electrical specifications

Part number	Light color, wavelength peak	Device power ratings				LED power ratings		
		DC voltage		Power consumption (W)	Max LED fwd current (mA)	Forward voltage		Max pulse current (mA)
		min (V)	max (V)			typ. (V)	max (V)	
TCCXQ xxx-G	green, 520 nm	12	24	< 2.5	350	3.3	4.00	2000
TCCXQ xxx-W	white	12	24	< 2.5	350	2.78	n.a.	2000

- 1 Used in continuous (not pulsed) mode.  
 2 At max forward current. Tolerance is  $\pm 0.06V$  on forward voltage measurements.

- 3 At pulse width  $\leq 10$  ms, duty cycle  $\leq 10\%$  condition.  
 Built-in electronics board must be bypassed (see tech info online).



TCCXQ 011-x

Part number (*)	Mag. (x)	Image circle Ø (mm)	Available colours		Detector type				Optical specifications Object distance d (mm)	Mechanical specifications			
			G	W	1/3"	1/2"	1/1.8"	2/3" - 5 Mpx		Mount	Length (mm)	Height (mm)	Width (mm)
					w x h (mm x mm)	w x h (mm x mm)	w x h (mm x mm)	w x h (mm x mm)					
<b>Object field of view (mm x mm)</b>													
TCCXQ 150-x	1.50	11	x	x	3.20 x 2.40	4.27 x 3.20	4.75 x 3.58	5.63 x 4.71	82.8	C	155.0	64	198.9
TCCXQ 100-x	1.00	11	x	x	4.80 x 3.60	6.40 x 4.80	7.13 x 5.37	8.45 x 7.07	82.8	C	155.0	64	182.5
TCCXQ 075-x	0.75	11	x	x	6.40 x 4.80	8.53 x 6.40	9.51 x 7.16	11.3 x 9.43	82.8	C	155.0	64	213.5
TCCXQ 066-x	0.66	11	x	x	7.27 x 5.45	9.70 x 7.27	10.8 x 8.10	12.8 x 10.7	82.8	C	155.0	64	207.8
TCCXQ 050-x	0.50	11	x	x	9.60 x 7.20	12.8 x 9.60	14.3 x 10.7	16.9 x 14.1	82.8	C	155.0	64	189.2
TCCXQ 024-x	0.24	11	x	x	19.8 x 14.8	26.3 x 19.8	29.3 x 22.1	34.8 x 29.1	20.1	C	235.9	88	252.4
TCCXQ 018-x	0.18	11	x	x	26.1 x 19.6	34.8 x 26.1	38.8 x 29.2	45.9 x 38.4	37.0	C	285.2	102	303.2
TCCXQ 016-x	0.16	11	x	x	30.6 x 22.9	40.8 x 30.6	45.4 x 34.2	53.8 x 45.0	50.7	C	319.2	108	336.7
TCCXQ 014-x	0.14	11	x	x	34.8 x 26.1	46.4 x 34.8	51.7 x 38.9	61.2 x 51.2	63.8	C	350.3	128	367.6
TCCXQ 011-x	0.11	11	x	x	43.6 x 32.7	58.2 x 43.6	64.8 x 48.8	76.8 x 64.3	90.1	C	415.6	144	433.1

(\*) The last digit of the part number "-x" defines the source colour.

# TC2MHR-TC4MHR series

High-resolution bi-telecentric lenses for large detectors up to 1.2"

## PRODUCT UPDATE



**TC2MHR and TC4MHR series** are high resolution bi-telecentric lenses designed for detectors larger than 2/3": TC2MHR lenses cover up to 1" detectors (16 mm diagonal) while TC4MHR lenses cover up to 21.5 mm detector diagonal (e.g. suitable for 1.2" detectors), making them the perfect choice for advanced metrology applications.

The re-designed TC2MHR-4MHR series outperforms the previous version featuring unmatched resolution, low distortion and homogeneous image quality while offering the best performance to price ratio.

TC2MHR-4MHR feature a compact and robust design that allows easy integration in industrial environments and additionally feature phase adjustment by simply loosening the set screws positioned in the eyepiece part.

In order to help the selection, some of the most commonly used large matrix detectors are listed: select the product that best suits your application by choosing the column where the your detector is listed and scrolling down the table until you find the field of view best matching your needs.

### KEY ADVANTAGES

**Wide image circle** for detectors larger than 2/3" .

**Excellent resolution and low distortion.**

**Simple and robust design** for industrial environments.

Detailed **test report** with **measured** optical parameters.

C, F and M42X1 (-E) **mount options** with easy phase adjustment.

### NEW DESIGN

- **Higher resolution and compact size.**
- **Best performance to price ratio.**
- **New M42x1 mount option.**



Mount C



Mount E = M42x1



Mount F



Part number	Mag. (x)	Image circle Ø (mm)	Detector type				Optical specifications						Dimensions							
			1"		1.2"		4/3"		WD (mm)	wF/#	Telecentricity typical (max) (deg)	Distortion typical (max) (%)	Field depth (mm)	CTF @50lp/mm (%)	Length (mm)			Diam. (mm)		
			KAI 2020 14.8 mm diag.	KAI-04050 16 mm diag.	KAI-4022/4021 21.5 mm diag.	KAI-08050 22.6 mm diag.	1	2							3	4	5	6	C	E
			w x h (mm x mm)	w x h (mm x mm)	w x h (mm x mm)	w x h (mm x mm)	7	1	2	3	4	5	6	C	E	F	C	E	F	
<b>TC2MHR lenses</b>			<b>Object field of view (mm x mm) 8</b>																	
TC2MHR 016-x	0.767	16.6	15.4 x 11.6	16.7 x 12.5	Ø = 19.8	Ø = 17.7	43.8	16	< 0.08 (0.10)	< 0.04 (0.10)	2.0	> 30	145.5	147.0	116.5	45	52	64		
TC2MHR 024-x	0.508	16.9	23.3 x 17.5	25.2 x 18.9	Ø = 29.9	Ø = 26.8	67.2	16	< 0.08 (0.10)	< 0.04 (0.10)	4.6	> 40	170.4	171.9	141.4	45	52	64		
TC2MHR 036-x	0.353	16.7	33.5 x 25.2	36.3 x 27.2	Ø = 43.1	Ø = 38.5	102.6	16	< 0.08 (0.10)	< 0.08 (0.10)	10	> 30	197.7	199.2	168.7	61	61	64		
TC2MHR 048-x	0.268	16.9	44.2 x 33.1	47.8 x 35.8	Ø = 56.7	Ø = 50.7	133.4	16	< 0.08 (0.10)	< 0.08 (0.10)	17	> 30	232.8	234.3	203.8	75	75	75		
TC2MHR 056-x	0.228	16.8	51.9 x 38.9	56.1 x 42.1	Ø = 66.7	Ø = 59.6	157.8	16	< 0.04 (0.08)	< 0.05 (0.10)	23	> 40	257.1	258.7	228.1	80	80	80		
TC2MHR 064-x	0.200	16.8	59.3 x 44.5	64.1 x 48.1	Ø = 76.1	Ø = 68.1	181.9	16	< 0.04 (0.08)	< 0.05 (0.10)	30	> 40	278.3	279.8	249.3	100	100	100		
TC2MHR 080-x	0.160	16.9	74.0 x 55.5	80.0 x 60.0	Ø = 95.0	Ø = 85.0	226.8	16	< 0.04 (0.08)	< 0.05 (0.10)	46	> 40	324.0	325.5	295.0	116	116	116		
TC2MHR 096-x	0.137	16.9	86.6 x 65.0	93.6 x 70.2	Ø = 111.2	Ø = 99.5	278.6	16	< 0.05 (0.10)	< 0.07 (0.10)	64	> 40	396.4	397.9	367.4	143	143	143		
TC2MHR 120-x	0.104	16.5	113.8 x 85.4	123.1 x 92.3	Ø = 146.2	Ø = 130.8	334.6	16	< 0.07 (0.10)	< 0.07 (0.10)	110	> 40	451.4	452.9	422.4	180	180	180		
TC2MHR 144-x	0.089	16.8	133.5 x 100.1	144.3 x 108.2	Ø = 171.4	Ø = 153.3	396.0	16	< 0.05 (0.10)	< 0.05 (0.10)	151	> 40	510.8	512.4	481.8	200	200	200		
TC2MHR 192-x	0.067	16.8	178.0 x 133.5	192.5 x 144.4	Ø = 228.6	Ø = 204.5	527.5	16	< 0.05 (0.10)	< 0.04 (0.10)	268	> 40	649.2	650.8	620.2	260	260	260		
TC2MHR 240-x	0.053	16.2	223.8 x 167.9	242.0 x 181.5	Ø = 287.3	Ø = 257.1	492.9	16	< 0.05 (0.10)	< 0.04 (0.10)	424	> 40	812.2	813.7	783.2	322	322	322		
<b>TC4MHR lenses</b>																				
TC4M 004-x	4.000	22.0	2.96 x 2.22	3.21 x 2.41	3.79 x 3.79	4.53 x 3.40	57.1	22	< 0.08 (0.10)	< 0.08 (0.10)	0.1	> 30	206.4	n.a.	178.4	45	n.a.	45		
TC4M 007-x	2.667	22.0	4.44 x 3.33	4.82 x 3.61	5.69 x 5.69	6.80 x 5.10	61.2	22	< 0.08 (0.10)	< 0.06 (0.10)	0.2	> 30	183.5	n.a.	155.4	45	n.a.	45		
TC4M 009-x	2.000	22.0	5.92 x 4.44	6.42 x 4.82	7.57 x 7.57	9.06 x 6.80	63.3	22	< 0.08 (0.10)	< 0.05 (0.10)	0.3	> 30	170.0	n.a.	142.0	45	n.a.	45		
TC4MHR 016-x	1.055	21.2	11.2 x 8.4	12.1 x 9.1	14.4 x 14.4	17.2 x 12.9	43.8	16	< 0.08 (0.10)	< 0.04 (0.10)	1.1	> 30	169.6	171.1	140.6	45	52	64		
TC4MHR 024-x	0.700	21.6	16.9 x 12.7	18.3 x 13.7	21.7 x 21.7	25.9 x 19.4	67.2	16	< 0.08 (0.10)	< 0.04 (0.10)	2.4	> 30	194.8	196.3	165.8	45	52	64		
TC4MHR 036-x	0.486	21.4	24.4 x 18.3	26.3 x 19.7	31.3 x 31.3	37.2 x 28.0	102.6	16	< 0.05 (0.10)	< 0.08 (0.10)	5.0	> 30	222.0	223.6	193.0	61	61	64		
TC4MHR 048-x	0.369	21.7	32.1 x 24.1	34.7 x 26.0	41.2 x 41.2	49.1 x 36.9	133.4	16	< 0.08 (0.10)	< 0.08 (0.10)	8.7	> 40	257.1	258.6	228.1	75	75	75		
TC4MHR 056-x	0.314	21.6	37.7 x 28.3	40.8 x 30.6	48.4 x 48.4	57.6 x 43.3	157.8	16	< 0.05 (0.10)	< 0.04 (0.10)	12.0	> 40	280.7	282.2	251.7	80	80	80		
TC4MHR 064-x	0.275	21.6	43.1 x 32.3	46.6 x 34.9	55.3 x 55.3	65.8 x 49.5	181.9	16	< 0.05 (0.10)	< 0.04 (0.10)	15.7	> 40	301.8	303.4	272.8	100	100	100		
TC4MHR 080-x	0.221	21.7	53.7 x 40.3	58.0 x 43.5	68.9 x 68.9	82.0 x 61.7	226.8	16	< 0.05 (0.10)	< 0.04 (0.10)	24.4	> 40	347.6	349.1	318.6	116	116	116		
TC4MHR 096-x	0.186	21.6	63.5 x 47.6	68.7 x 51.5	81.6 x 81.6	97.1 x 73.0	278.6	16	< 0.05 (0.10)	< 0.04 (0.10)	34.2	> 35	392.8	394.3	363.8	143	143	143		
TC4MHR 120-x	0.143	21.2	82.6 x 62.0	89.3 x 67.0	106.1 x 106.1	126.3 x 94.9	334.6	16	< 0.05 (0.10)	< 0.04 (0.10)	57.8	> 30	475.2	476.7	446.2	180	180	180		
TC4MHR 144-x	0.122	21.6	96.9 x 72.7	104.7 x 78.6	124.4 x 124.4	148.1 x 111.3	396.0	16	< 0.05 (0.10)	< 0.04 (0.10)	79.5	> 30	537.7	539.2	508.7	200	200	200		
TC4MHR 192-x	0.092	21.6	129.4 x 97.0	139.9 x 104.9	166.1 x 166.1	197.8 x 148.6	527.6	16	< 0.05 (0.10)	< 0.04 (0.10)	141.8	> 30	679.1	680.7	650.1	260	260	260		
TC4MHR 240-x	0.073	21.1	161.7 x 121.3	174.9 x 131.1	207.7 x 207.7	247.3 x 185.8	492.9	16	< 0.05 (0.10)	< 0.05 (0.10)	221.5	> 30	827.3	828.8	798.3	322	322	322		

- Working distance: distance between the front end of the mechanics and the object. Set this distance within +/- 3% of the nominal value for maximum resolution and minimum distortion.
- Working F-number (wF/#): the real F-number of a lens when used as a macro. Lenses with smaller apertures can be supplied on request.
- Maximum slope of chief rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement. Typical (average production) values and maximum (guaranteed) values are listed.
- Percent deviation of the real image compared to an ideal, undistorted image: typical (average production) values and maximum (guaranteed) values are listed.
- At the borders of the field depth the image can be still used for measurement but, to get a perfectly sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 5 µm.
- Measured from the front end of the mechanics to the camera flange.
- With KAI-08050 (22,6 mm diagonal) detectors, the FOV of TC4MHR yyy lenses may show some vignetting at the image corners.
- For the fields with the indication "Ø =", the image of a circular object of such diameter is fully inscribed into the detector.

#### Ordering information

It's easy to select the right lens for your application: our part numbers are coded as **TC2MHR yyy-x** or **TC4MHR yyy-x** where **yyy** refers to the width dimension of the object field of view (FOV) in millimeters and **-x** refers to the mount option:

- C for C-mount
- F for F-mount
- E for M42X1 mount (flange distance FD 16 mm).

E.g. TC4MHR064-F for an F-mount TC 4MHR 064 lens. Customized mounts are also available upon request.

# TC16M series

Bi-telecentric lenses for 35 mm and 4 k / 8 k pixel line detectors



**TC16M series** bi-telecentric lenses have been specifically designed to fit 35 mm format (36 x 24 mm) detectors with very high resolution, such as 11, 16 or 29 Mpx.

This combination is the typical choice for extremely accurate measurement of large items such as engine parts, glass or metal sheets, PCBs and electronic components, LCDs, etc.

TC16M lenses are also perfectly suitable for 4 kpx and 8 kpx linescan cameras and can be successfully used to determine the diameter of cylindrical objects: for example shafts, turned metal parts, machine tools, etc.

Besides the standard F and M58x0.75 mount options, any other mechanical interface can be supplied upon request.

## KEY ADVANTAGES

**Wide image circle** for large detectors up to 43.3 mm.

**Excellent resolution and low distortion.**

**Simple and robust design** for industrial environments.

Detailed **test report** with **measured** optical parameters.

## DO YOU KNOW?

Why Opto Engineering telecentric lenses don't integrate an iris?  
Check the answer to this and other FAQ directly on our web page at:  
[www.opto-engineering.com/faqs](http://www.opto-engineering.com/faqs)



Mount F



Mount Q = M58x0.75

## EXTENDED RANGE

TC16M series is now available with a new mount option: -Q = M58 x 0.75





Part number	Mag. (x)	Image circle Ø (mm)	Detector type				Optical specifications						Dimensions			
			Line 2 kpx	Line 4 kpx	Line 8 kpx	Full frame 35 mm	WD	wF/#	Telecentricity	Distortion	Field Depth	CTF	Length		Diam.	
			2 k x 10 µm	4 k x 7 µm	8 k x 5 µm	w x h	(mm)		typical (max)	typical (max)	(mm)	@50lp/mm	(mm)	(mm)	(mm)	(mm)
<b>Object field of view (mm)</b>																
							<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>		<b>6</b>	<b>7</b>	<b>F</b>	<b>Q</b>
TC16M 009-x	4.000	43.3	5.12	7.17	10.2	9.00 x 6.00	57.8	22	< 0.03 (0.05)	< 0.03 (0.05)	0.1	> 20	487.9	527.9	64	64
TC16M 012-x	3.000	43.3	6.83	9.56	13.7	12.0 x 8.00	57.8	18	< 0.03 (0.05)	< 0.03 (0.05)	0.15	> 30	378.7	418.7	64	64
TC16M 018-x	2.000	43.3	10.2	14.3	20.5	18.0 x 12.0	57.8	16	< 0.03 (0.05)	< 0.03 (0.05)	0.3	> 40	259.6	299.5	64	64
TC16M 036-x	1.000	43.3	20.5	28.7	41.0	36.0 x 24.0	102.6	16	< 0.03 (0.05)	< 0.02 (0.03)	1.2	> 30	309.0	348.9	64	64
TC16M 048-x	0.751	43.3	27.3	38.2	54.6	47.9 x 32.0	125.6	16	< 0.06 (0.10)	< 0.05 (0.10)	2.1	> 30	315.2	355.2	75	75
TC16M 056-x	0.641	43.3	31.9	44.7	63.9	56.1 x 37.4	148.6	16	< 0.04 (0.08)	< 0.04 (0.10)	2.9	> 40	338.5	378.5	80	80
TC16M 064-x	0.561	43.3	36.5	51.1	73.1	64.2 x 42.8	170.6	16	< 0.04 (0.08)	< 0.06 (0.15)	3.8	> 30	359.6	399.6	100	100
TC16M 080-x	0.463	43.3	44.2	61.9	88.4	77.7 x 51.8	197.3	16	< 0.03 (0.08)	< 0.09 (0.20)	4.9	> 30	406.4	446.4	116	116
TC16M 096-x	0.380	43.3	53.9	75.4	107.7	94.7 x 63.1	262.3	16	< 0.06 (0.08)	< 0.07 (0.15)	8.3	> 40	449.2	489.1	143	143
TC16M 120-x	0.289	43.3	70.9	99.3	141.9	124.7 x 83.1	331.6	16	< 0.05 (0.08)	< 0.05 (0.10)	14.5	> 40	538.1	578.1	180	180
TC16M 144-x	0.245	43.3	83.6	117.0	167.1	146.9 x 97.9	397.4	16	< 0.05 (0.08)	< 0.08 (0.20)	20	> 40	597.8	637.7	200	200
TC16M 192-x	0.187	43.3	109.5	153.3	219.0	192.0 x 128.0	457.5	16	< 0.06 (0.08)	< 0.05 (0.10)	34	> 40	742.0	781.5	260	260
TC16M 240-x	0.150	43.3	136.5	191.1	273.1	240.0 x 160.0	542.8	16	< 0.06 (0.08)	< 0.08 (0.15)	53	> 40	899.0	938.7	322	322

- Working distance: distance between the front end of the mechanics and the object. Set this distance within +/- 3% of the nominal value for maximum resolution and minimum distortion.
- Working F-number (wF/#): the real F-number of a lens when used as a macro. Lenses with smaller apertures can be supplied on request.
- Maximum slope of chief rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement. Typical (average production) values and maximum (guaranteed) values are listed.

- Percent deviation of the real image compared to an ideal, undistorted image: typical (average production) values and maximum (guaranteed) values are listed.
- At the borders of the field depth the image can be still used for measurement but, to get a perfectly sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 5 µm.
- Measured from the front end of the mechanics to the camera flange.
- Q= M58X0.75 FD 6.56; FD stands for Flange Distance (in mm), defined as the distance from the mounting flange (the "metal ring" in rear part of the lens) to the camera detector plane.

#### Ordering information

It's easy to select the right lens for your application: our part numbers are coded as **TC16M yyy-x** where **yyy** refers to the width dimension of the object field of view (FOV) in millimeters and **-x** refers to the mount option:

- F for F-mount
  - Q for M58x0.75 mount (M58x0.75 flange distance FD 6.56 mm).
- TC16M064-Q for a TC16M064 with M58x0.75 mount.

# TC4K series

Flat telecentric lenses for 4 k pixel linescan cameras

**NEW**



#### KEY ADVANTAGES

##### Compact design

“Flat” shape for easy integration.

##### Easy rotational phase and focus adjustment

Robust and precise tuning of FOV phase angle and best focus position.

##### Compatible LTCL4K telecentric illuminators

with matching flat design.

##### Dedicated CMMR4K mirrors

90° deflection of the light path for usage in tight spaces and easy integration.

**TC4K series** telecentric lenses have been designed for measurement applications using linescan cameras with a detector size up to 28.7 mm (e.g. 4096 pixels with pixel size 7  $\mu\text{m}$ ). Dimensional constraints are often a major issue when designing image scanning systems where the sample or the camera itself must be moved: TC4K series is the Opto Engineering solution for applications and machines with tight dimensional constraints. Compatible LTCL4K illuminators with matching flat design and dedicated accessories allow for optical combinations that fit most geometrical measurement configurations. TC4K series feature standard F or M42 mount to fit common linescan camera interfaces; additional mounts are available upon request. Moreover, the lens-camera interface provides both fine detector phase adjustment and a precise focusing mechanism. Detector phase adjustment allows to precisely position the linear FOV at 90° from the object movement direction.

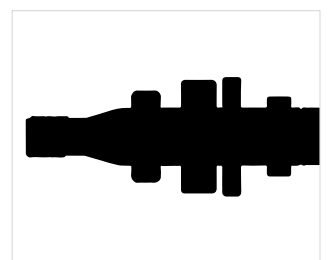
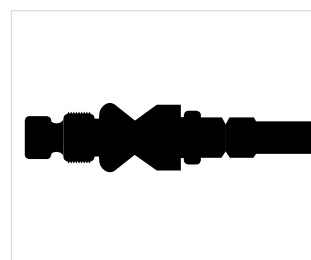
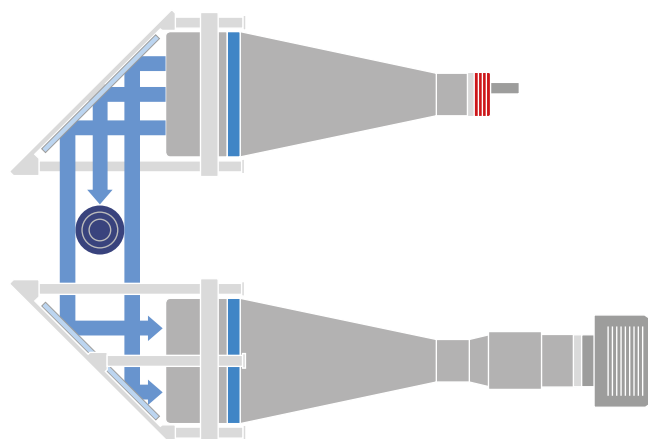


Mount F



Mount N = M42x1

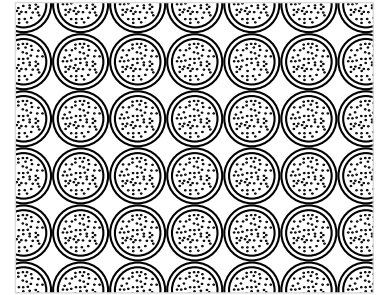
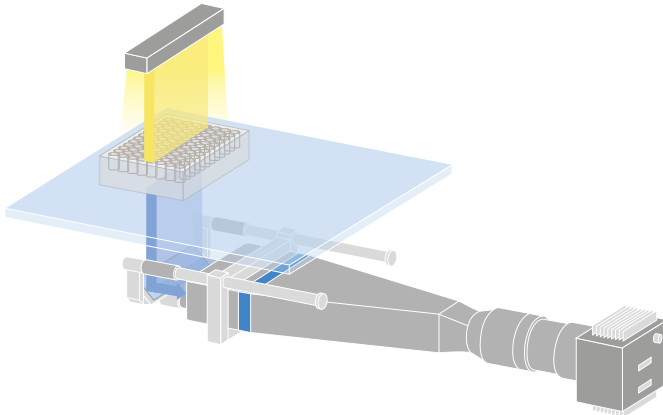
#### Application examples



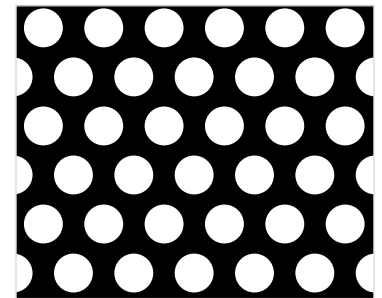
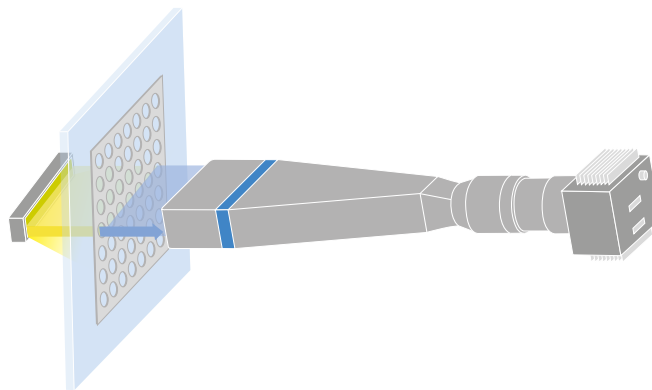
Engine shaft measurement performed with TC4K lens coupled to LTCL4K telecentric illuminator by means of two CMMR4K deflecting mirrors.



Cell count in a Petri dish performed with TC4K lens used in combination with CMMR4K deflecting mirror and a back light.



Metal sheet measurement performed by TC4K lens and diffused backlight illumination.



Part number	Mag. (x)	Image width (mm)	Detector type		Optical specifications					Mechanical specifications								
			Line - 2 kpx 2k x 10 μm	Line - 4 kpx 4k x 7 μm	WD (mm)	wF/#	Telecentricity (deg)	Distortion (%)	Field depth (mm)	CTF @50lp/mm (%)	Flange distance		Length		Width		Height	
			20.5 (mm)	28.7 (mm)	1	2	3	4	5	F	N	F	N	F	N	F	N	
TC4K 060-x	0.48	28.7	42.8	60.0	174.0	16	0.06 (0.10)	0.05 (0.08)	7.3	> 30	46.5	10.6	319.2	355.2	83	83	64	52
TC4K 090-x	0.32	28.7	64.3	90.0	174.0	16	0.05 (0.10)	0.05 (0.08)	16.4	> 30	46.5	10.6	360.7	396.6	114	114	64	52
TC4K 120-x	0.24	28.7	85.4	119.6	174.0	16	0.10 (0.12)	0.08 (0.10)	29.2	> 25	46.5	10.6	337.3	373.2	114	114	64	52
TC4K 180-x	0.16	28.7	128.6	180.0	254.0	16	0.08 (0.10)	0.08 (0.10)	65.6	> 30	46.5	10.6	522.4	558.4	208	208	64	52

- Working distance: distance between the front end of the mechanics and the object. Set this distance within +/- 3% of the nominal value for maximum resolution and minimum distortion.
- Working F-number (wF/#): the real F-number of a lens when used as a macro. Lenses with smaller apertures can be supplied on request.
- Maximum slope of chief rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement. Typical (average production) values and maximum (guaranteed) values are listed.

- Percent deviation of the real image compared to an ideal, undistorted image: typical (average production) values and maximum (guaranteed) values are listed.
- At the borders of the field depth the image can be still used for measurement but, to get a perfectly sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 7 μm.
- Measured from the front end of the mechanics to the camera flange.

#### Ordering information

It's easy to select the right lens for your application: our part numbers are coded as **TC4K yyy -x** where **yyy** refers to the field of view (FOV) in millimeters and **-x** refers to the mount option:  
 - **F** for F-mount  
 - **N** for M42x1 mount (flange distance FD 10.56 mm).  
 E.g. TC4K060-N for a TC4K060 with M42x1 mount.

# TC12K series

Telecentric lenses for 12 k and 16 k pixel linescan cameras

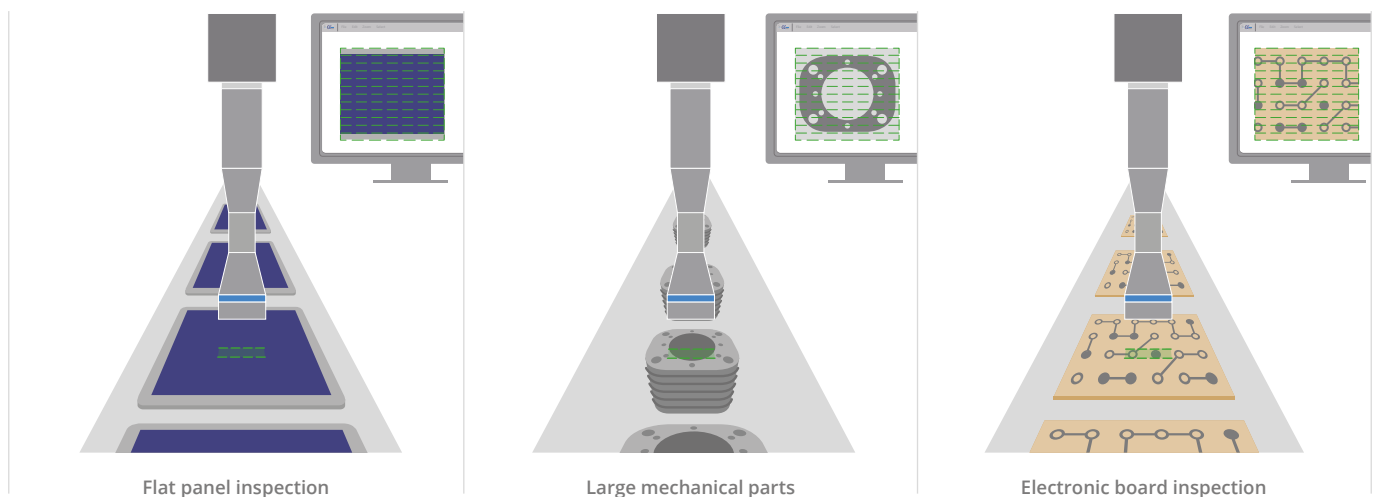


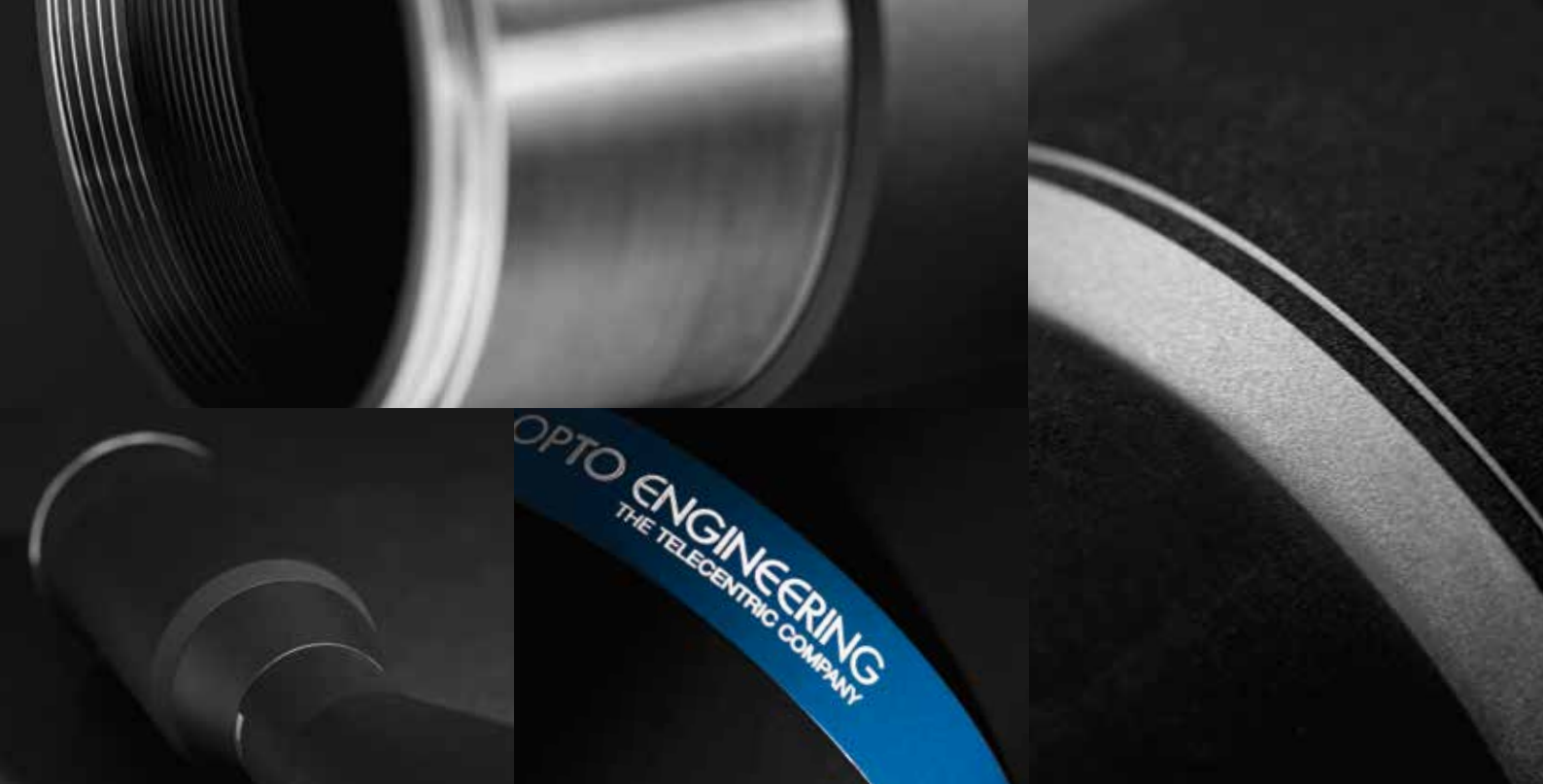
**TC12K series telecentric lenses** are designed to fit very large line detector cameras. An image circle diameter larger than 62 mm combined with the very high resolution featured by this lens family makes TC12K series the solution of choice for 12 k and 16 k pixel cameras. Flat panel display, solar cell and electronic board inspection are among the most common applications of these optics in the

electronics industry; at the same time the optical specifications make them perfectly suitable for large mechanical parts accurate measurement.

In addition to the standard M72x0.75 mount, TC12K lenses can be equipped with other camera mounts at no additional cost ensuring wide compatibility with most common linescan cameras.

## Application examples





### Wide image circle

TC12K is optimized to cover line scan sensor sizes up to 62.4 mm.

SENSOR SIZE								UP TO 62.4 mm
2048 px x 10 $\mu$ m	2048 px x 14 $\mu$ m	4096 px x 7 $\mu$ m	4096 px x 10 $\mu$ m	7450 px x 4.7 $\mu$ m	6144 px x 7 $\mu$ m	8192 px x 7 $\mu$ m	12288 px x 5 $\mu$ m	
20.5 mm	28.6 mm	28.6 mm	35 mm	41 mm	43 mm	57.3 mm	62 mm	

TC12K

### Phase adjustment

Adjusting the phase of the camera mounted on TC12K telecentric lenses is easy: simply loosen the three set screws and rotate the camera mount until you achieve the desired angular alignment.



Part number	Mag. (x)	Image circle $\varnothing$ (mm)	Detector type				Optical specifications						Dimensions		
			Line - 8 kpx 8 k x 7 $\mu$ m	Line - 16 kpx 16 k x 3.5 $\mu$ m	Line - 12 kpx 12 k x 5 $\mu$ m	Line - 12 kpx 12 k x 5.2 $\mu$ m	WD	wF/#	Telecentricity typical (max) (deg)	Distortion typical (max) (%)	Field depth (mm)	CTF @50lp/mm (%)	Mount	Length (mm)	Diam. (mm)
			57.3 (mm)	57.3 (mm)	61.4 (mm)	62.4 (mm)	1	2	3	4	5	7	6		
			Object field of view (mm)												
TC12K 064	0.960	62.4	59.7	59.7	64.0	65.0	162.8	16	< 0.06 (0.08)	< 0.08 (0.10)	1.3	> 35	M72 x 0.75 - FD 6.56	566.7	100
TC12K 080	0.698	62.4	82.2	82.2	88.1	89.5	157.4	16	< 0.06 (0.08)	< 0.08 (0.10)	2.5	> 35	M72 x 0.75 - FD 6.56	541.9	116
TC12K 120	0.529	62.4	108.4	108.4	116.1	117.9	254.0	16	< 0.06 (0.08)	< 0.06 (0.08)	4.3	> 40	M72 x 0.75 - FD 6.56	722.1	180
TC12K 144	0.439	62.4	130.6	130.6	140.0	142.2	237.9	16	< 0.06 (0.08)	< 0.07 (0.10)	6.2	> 40	M72 x 0.75 - FD 6.56	743.3	200
TC12K 192	0.320	62.4	179.4	179.4	192.3	195.3	265.5	16	< 0.06 (0.08)	< 0.08 (0.10)	11.7	> 35	M72 x 0.75 - FD 6.56	857.5	260
TC12K 240	0.260	62.4	220.5	220.5	236.3	240.0	492.8	16	< 0.06 (0.08)	< 0.08 (0.10)	17.8	> 35	M72 x 0.75 - FD 6.56	1072.8	322

- Working distance: distance between the front end of the mechanics and the object. Set this distance within +/- 3% of the nominal value for maximum resolution and minimum distortion.
- Working F-number (wF/#): the real F-number of a lens when used as a macro. Lenses with smaller apertures can be supplied on request.
- Maximum slope of chief rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement.
- Percent deviation of the real image compared to an ideal, undistorted image: typical (average production) values and maximum (guaranteed) values are listed.
- At the borders of the field depth the image can be still used for measurement but, to get a perfectly sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 5  $\mu$ m.
- Measured from the front end of the mechanics to the camera flange.
- FD stands for Flange Distance (in mm), defined as the distance from the mounting flange (the "metal ring" in rear part of the lens) to the camera detector plane.

# LTCLHP series

Telecentric high-performance illuminators



## KEY ADVANTAGES

### Complete light coupling

All the light emitted by a LTCLHP source is collected by a telecentric lens and transferred to the camera detector, ensuring very high signal-to-noise ratios.

### Border effects removal

Diffused back-illuminators often make objects seem smaller than their actual size because of light reflections on the object sides, while collimated rays are typically much less reflected.

### Field depth and telecentricity improvement

Collimated illumination geometry increases a telecentric lens natural field depth and telecentricity far beyond its nominal specs.

**LTCLHP series** are high-performance telecentric illuminators specifically designed to back illuminate objects imaged by telecentric lenses.

LTCLHP telecentric illuminators offer higher edge contrast when compared to diffused back light illuminators and therefore higher measurement accuracy.

This type of illumination is especially recommended for high accuracy measurement of round or cylindrical parts where diffusive back lighting would offer poor performances because of the diffuse reflections coming from the edges of objects under inspection.

## NEW FEATURES

- Excellent **illumination stability** featuring no light flickering thanks to very high current stability over time even at low currents.
- Precise **light intensity** tuning thanks to the leadscrew multi-turn trimmer positioned in the back.
- **Easy LED source replacement** and alignment for all the LED colors offered by Opto Engineering.

Part number (*)	Beam diameter (mm)	Available colours				Optical specs	Mechanical specs		Compatibility
		R	G	B	W	Working distance range (mm)	Length (mm)	Outer diameter (mm)	
		<b>1</b>					<b>2</b>		
<b>LTCLHP 023-x</b>	16	x	x	x	x	45 ~ 90	96.8	28	TC2300y, TC23012, TC4M00y-x,
<b>LTCLHP 016-x</b>	20	x	x	x	x	35 ~ 70	99.9	38	TCxx016, TC4MHR016-x, TC2MHR016-x, TCLWD series
<b>LTCLHP 024-x</b>	30	x	x	x	x	45 ~ 90	124.7	44	TCxx024, TCxMHR024-x, TC16M009-x, TC16M012-x, TC16M018-x
<b>LTCLHP 036-x</b>	45	x	x	x	x	70 ~ 140	152.1	61	TCxx036, TCxMHR036-x, TC16M036-x
<b>LTCLHP 048-x</b>	60	x	x	x	x	90 ~ 180	187.2	75	TCxx048, TCxMHR048-x, TC16M048-x
<b>LTCLHP 056-x</b>	70	x	x	x	x	100 ~ 200	210.5	80	TCxx056, TCxMHR056-x, TC16M056-x
<b>LTCLHP 064-x</b>	80	x	x	x	x	120 ~ 240	231.6	100	TCxx064, TCxMHR064-x, TC16M064-x, TC12K064
<b>LTCLHP 080-x</b>	100	x	x	x	x	150 ~ 300	277.2	116	TC23072, TCxx080, TCxMHR080-x, TC16M080-x, TC12K080
<b>LTCLHP 096-x</b>	120	x	x	x	x	200 ~ 250	322.2	143	TC23085, TCxx096, TCxMHR096-x, TC16M096-x
<b>LTCLHP 120-x</b>	150	x	x			220 ~ 440	408.2	180	TC23110, TCxx120, TCxMHR120-x, TC16M120-x, TC12K120
<b>LTCLHP 144-x</b>	180	x	x			270 ~ 540	467.2	200	TC23130, TCxx144, TCxMHR144-x, TC16M144-x, TC12K144
<b>LTCLHP 192-x</b>	250	x	x			350 ~ 700	608.2	260	TC23172, TCxx192, TCxMHR192-x, TC12K192
<b>LTCLHP 240-x</b>	300	x	x			350 ~ 700	769.2	322	TC23200, TC23240, TCxMHR240-x

(\*) The last digit of the part number "-x" defines the source colour.

**1** Opto Engineering recommends green light for high precision measurement applications.

**2** Nominal value, with no spacers in place.



### Precise light intensity tuning

Easily and precisely tune the light intensity level thanks to the leadscrew multi-turn trimmer positioned in the back.



### Direct LED control

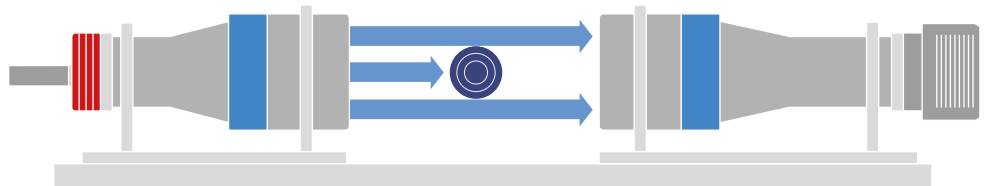
The built-in electronics can be bypassed in order to drive the LED directly for use in continuous or pulsed mode.

When bypassed, built-in electronics behave as an open circuit allowing direct control of the LED source.

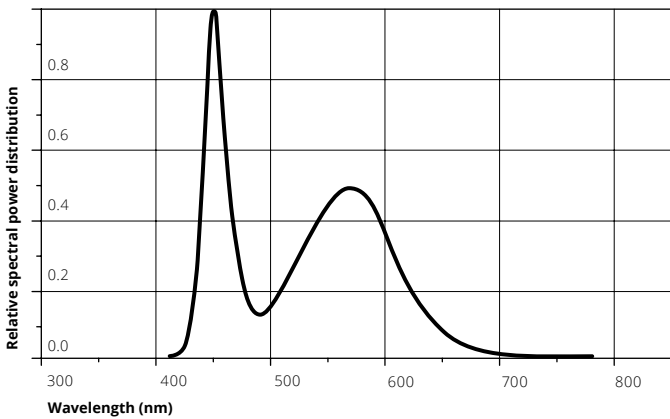


### Easy and precise alignment with bi-telecentric lenses

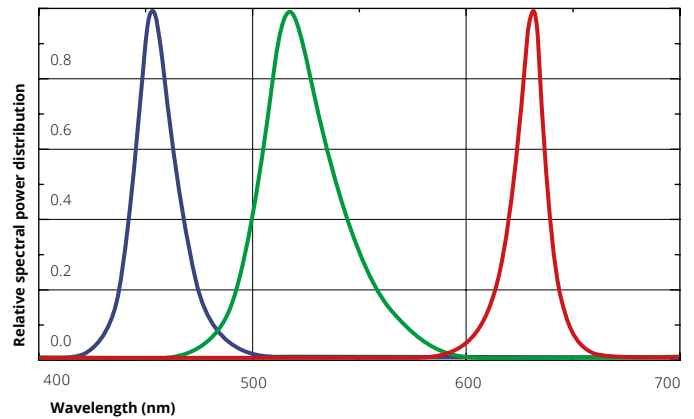
Create the perfect optical bench for precision measurement applications by interfacing our bi-telecentric lenses and LTCLHP collimated illuminators using Opto Engineering precision clamping mechanics CMHO series.



### Typical emission spectrum of white LEDs



### Typical emission spectrum of R,G,B LEDs



### Wide selection of different colors

Part number	Light color, wavelength peak	Device power ratings				LED power ratings		
		DC voltage		Power consumption (W)	Max LED fwd current (mA)	Forward voltage		Max pulse current (mA)
		min (V)	max (V)			typical (V)	max (V)	
LTCLHP xxx-R	red, 630 nm	12	24	< 2.5	350	2.4	3.00	2000
LTCLHP xxx-G	green, 520 nm	12	24	< 2.5	350	3.3	4.00	2000
LTCLHP xxx-B	blue, 460 nm	12	24	< 2.5	350	3.3	4.00	2000
LTCLHP xxx-W	white	12	24	< 2.5	350	2.78	n.a.	2000

1 Used in continuous (not pulsed) mode.

2 At max forward current. Tolerance is  $\pm 0.06V$  on forward voltage measurements.

3 At pulse width  $\leq 10$  ms, duty cycle  $\leq 10\%$  condition.

Built-in electronics board must be bypassed (see tech info online).

# LTCL4K series

Flat telecentric illuminators for linescan cameras

**NEW**



#### KEY ADVANTAGES

##### Compact design

"Flat" shape for easy integration.

##### High optical throughput and enhanced field depth

When coupled with compatible TC4K telecentric lenses.

##### Dedicated CMMR4K mirrors

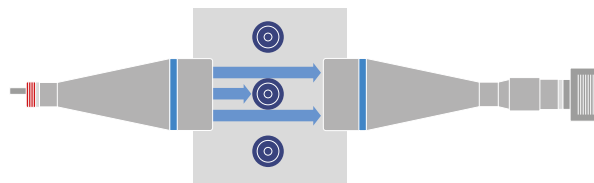
Right-angle deflection of the light path for usage in tight spaces.

**LTCL4K telecentric illuminators** are specifically designed to be paired with TC4K telecentric lenses, in order to provide the high optical throughput needed for high-speed linescan measurement applications involving for instance steering components, gear and cam shafts, grinding and turning parts. These illuminators are equipped with state-of-the-art LED driving electronics, providing exceptional illumination stability, precise light

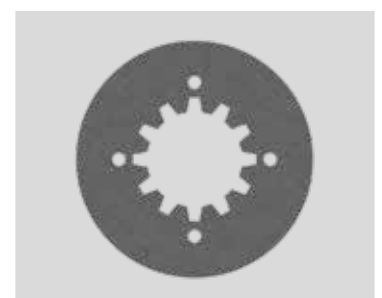
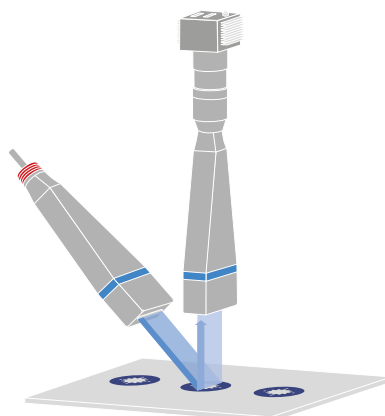
intensity tuning and easy replacement of the LED source. The unique "slim" form factor allows these units to be used in constrained spaces, often a critical factor in many industrial environments. Also, CMMR4K deflecting mirror accessories can be integrated to quickly assemble different illumination geometries, compatible with most type of inspection configurations.

#### Application examples

A LTCL4K back-illuminating a mechanical component and interfaced to a TC4K telecentric lens.



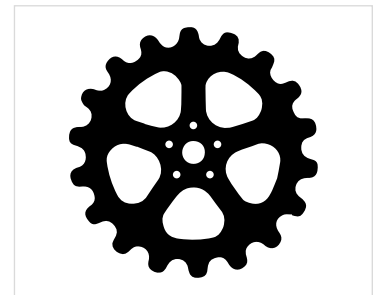
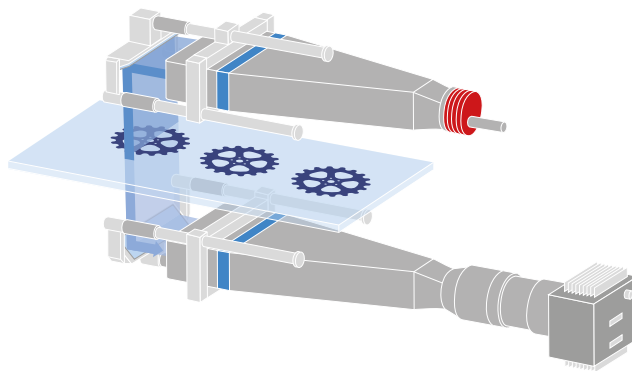
A LTCL4K directly illuminating a sample and serving as a linear telecentric illuminator.







A LTCL4K illuminator coupled with a TC4K lens using a CMMR4K deflecting mirrors to scan samples on a glass surface.



### Precise light intensity tuning

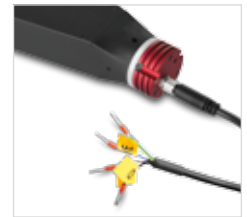
Easily and precisely tune the light intensity level thanks to the leadscrew multi-turn trimmer positioned in the back.



### Direct LED control

The built-in electronics can be bypassed in order to drive the LED directly for use in continuous or pulsed mode.

When bypassed, built-in electronics behave as an open circuit allowing direct control of the LED source.



## Electrical specifications

Part number	Light color, wavelength peak	Device power ratings			LED power ratings			
		DC voltage		Power consumption (W)	Max LED fwd current (mA)	Forward voltage		Max pulse current (mA)
		min (V)	max (V)			typical (V)	max (V)	
LTCL4Kxxx-G	green, 520 nm	12	24	< 2.5	350	3.3	4.00	2000
LTCL4Kxxx-W	white	12	24	< 2.5	350	2.78	n.a.	2000

<sup>1</sup> Used in continuous (not pulsed) mode.

<sup>2</sup> At max forward current. Tolerance is ±0.06V on forward voltage measurements.

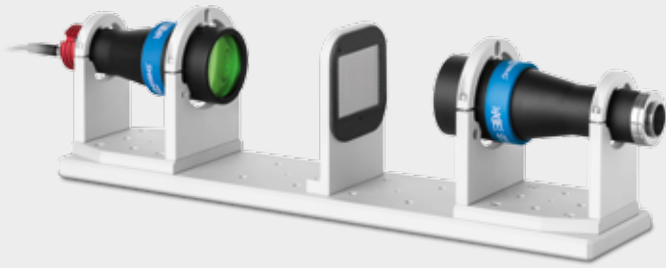
<sup>3</sup> At pulse width ≤ 10 ms, duty cycle ≤ 10% condition.

Built-in electronics board must be bypassed (see tech info online).

Part number	Optical specifications				Mechanical specifications			Compatibility Compatible TC4K
	Light color, wavelength peak	Beam width (mm)	Beam height (mm)	Working distance range (mm)	Length (mm)	Width (mm)	Height (mm)	
LTCL4K060-G	green, 520 nm	71	10	90-300	218.3	83	38.5	TC4K060-x
LTCL4K060-W	white	71	10	90-300	218.3	83	38.5	TC4K060-x
LTCL4K090-G	green, 520 nm	102	10	90-300	295.2	114	38.5	TC4K090-x
LTCL4K090-W	white	102	10	90-300	295.2	114	38.5	TC4K090-x
LTCL4K120-G	green, 520 nm	132	10	90-300	306.3	144	38.5	TC4K120-x
LTCL4K120-W	white	132	10	90-300	306.3	144	38.5	TC4K120-x
LTCL4K180-G	green, 520 nm	187	10	120-450	483.5	206	38.5	TC4K180-x
LTCL4K180-W	white	187	10	120-450	483.5	206	38.5	TC4K180-x

# TCBENCH series

TC optical bench kits for easy measurements



## KEY ADVANTAGES

### Pre-assembled setup

Just attach your camera, and the bench is ready for measurement.

### Best optical performances

The bench is pre-set to provide unpaired measurement accuracy.

### Tested system

The bench is quality tested as a whole system.

**TCBENCH series** are complete optical systems designed for hassle-free development of demanding measurement applications.

### Each kit integrates:

- 1 TC bi-telecentric lens for 2/3" detectors
- 1 LTCLHP telecentric illuminator (green)
- 2 CMHO mechanical clamps
- 1 CMPT base-plate
- 1 PT chrome-on-glass calibration pattern
- 1 CMPH pattern holder

The benches come ready to be used, pre-assembled and pre-aligned to assure the best accuracy that a telecentric measurement system can deliver.

The collimated light source is set in order to optimize both illumination homogeneity and relevant optical parameters: distortion, telecentricity and resolution.

Coupling a LTCL illuminator with a telecentric lens increases the natural field depth of the lens; this is particularly true for 2/3" detector lenses where the acceptance angle of ray bundles is much larger than the divergence of the collimating source.

For this reason these benches feature unmatched image resolution and field depth.

Opto Engineering measures the optical performances of each TCBENCH and provides an individual test report. TCBENCH also benefits from a special price policy, combining high-end performances with cost effectiveness.

Part number	Mag. (x)	Image circle Ø (mm)	Detector type			Optical specifications				Dimensions				
			1/2" w x h	1/1.8" w x h	2/3" - 5 Mpx w x h	Optical Accuracy (µm)	Optical Accuracy (%)	Field Depth (mm)	CTF @70lp/mm (%)	Mount	Length (mm)	Width (mm)	Height (mm)	Weight (g)
			6.40 x 4.80 (mm x mm)	7.13 x 5.37 (mm x mm)	8.45 x 7.07 (mm x mm)	1	2							
			Field of view (mm x mm)											
<b>TCBENCH 009</b>	1.000	11.0	6.40 x 4.80	7.13 x 5.37	8.44 x 7.06	< 5	< 0.06%	1.2	> 35	C	282.0	56.0	78.5	900
<b>TCBENCH 016</b>	0.528	11.0	12.1 x 9.09	13.5 x 10.2	16.0 x 13.4	< 8	< 0.05%	2.9	> 40	C	297.0	65.5	81.2	1200
<b>TCBENCH 024</b>	0.350	11.0	18.3 x 13.7	20.4 x 15.3	24.1 x 20.2	< 13	< 0.05%	7	> 55	C	391.0	65.5	78.5	1340
<b>TCBENCH 036</b>	0.243	11.0	26.3 x 19.7	29.3 x 22.1	34.7 x 29.0	< 22	< 0.06%	14	> 50	C	529.0	103.0	140.5	4150
<b>TCBENCH 048</b>	0.184	11.0	34.8 x 26.1	38.8 x 29.2	46.0 x 38.4	< 31	< 0.06%	24	> 50	C	636.0	117.0	147.5	5600
<b>TCBENCH 056</b>	0.157	11.0	40.7 x 30.6	45.4 x 34.2	53.8 x 45.0	< 36	< 0.06%	33	> 55	C	701.0	122.0	150.0	7300
<b>TCBENCH 064</b>	0.138	11.0	46.6 x 34.9	51.9 x 39.1	61.4 x 51.4	< 40	< 0.06%	43	> 65	C	845.0	143.0	160.5	8700
<b>TCBENCH 080</b>	0.110	11.0	58.0 x 43.5	64.6 x 48.7	76.5 x 64.0	< 55	< 0.07%	67	> 55	C	915.0	158.0	168.0	11100
<b>TCBENCH 096</b>	0.093	11.0	68.5 x 51.4	76.3 x 57.5	90.4 x 75.6	< 70	< 0.07%	94	> 50	C	1053.0	206.5	185.0	15300

<sup>1,2</sup> Maximum measurement error without software calibration; standard image correction libraries yield close to zero measurement error.

# TCKIT case

Telecentric optics selection for machine vision labs



The **Opto Engineering TCKIT case** includes a selection of some of the most commonly used telecentric optics in measurement applications.

A kit of four C-mount telecentric lenses covers FOVs ranging from 9 mm to 64 mm, offering good coverage of many measurement applications. These lenses are suitable for detectors up to 2/3", so that most cameras can be used in combination with this set of optics. In addition, a LTCLHP 036-G collimated light source (green color) is included in the box; this illuminator can be coupled with the

three smaller telecentric lenses in order to demonstrate the several benefits of collimated illumination.

The telecentric kit case is a very helpful tool for system integrators and research centers that are frequently dealing with new machine vision applications.

The TCKIT case also benefits from our special educational price: you should seriously consider to buy this kit for your laboratory and discover the advantages of bi-telecentric optics!



Part number	Products included	Description
	<b>TC 23 064</b>	Bi-telecentric lens for 2/3", 64 x 48 mm FOV
	<b>TC 23 036</b>	Bi-telecentric lens for 2/3", 36 x 27 mm FOV
<b>TCKIT</b>	<b>TC 23 016</b>	Bi-telecentric lens for 2/3", 16 x 12 mm FOV
	<b>TC 23 009</b>	Bi-telecentric lens for 2/3", 8,8 x 6,6 mm FOV
	<b>LTCLHP 036-G</b>	Telecentric HP illuminator, beam diameter 45 mm, green

## PRODUCT UPGRADE

TCBENCH series now includes LTCLHP high-performance telecentric illuminator with unmatched illumination stability



# One product, multiple optical magnifications, infinite flexibility.

Multi Mag optics represent the ideal answer to many non-contact machine vision applications that require different optical magnifications to check geometrically complex parts at various levels of detail, maximizing measurement accuracy.

Fixed magnification telecentric lenses are an excellent choice for accurate measurement but may not be flexible enough to inspect very small features on larger samples; Moreover, if you need to accurately measure multiple sized objects (for example a set of screws), two or more fixed lenses would be needed to get the best image for each format. Standard zoom lenses may be a good alternative, often trading convenience for modest results in terms of accuracy and repeatability.

Moreover, infinite conjugate lenses like photographic equipment optics will not properly work when used to observe objects from up close.

## **The following product series are designed to overcome these limitations:**

the TCDP bi-telecentric double port, TCZR bi-telecentric zoom revolver and MCZR macro zoom revolver. They all come with extensive documentation - including specific control software - and support accessories.





Multi Mag optics

# TCDP series

Double port bi-telecentric lens for detector up to 2/3"



### KEY ADVANTAGES

**Double FOV and magnification**  
Combining accuracy with flexibility.

**No need of re-calibrating**  
Since the two magnifications are fixed.

**No change in image centering**  
When switching to another FOV.

### SETUP

Please refer to our website for setup instructions.  
[www.opto-engineering.com](http://www.opto-engineering.com)

**TCDP series** are double port bi-telecentric lenses supporting two different cameras to measure objects with different magnification factors. 2X and 4X options are available for imaging one half or one fourth of the full FOV: this can be simply accomplished by switching from one camera to the other with your software application. Since this technique does not require any moving mechanism we

can ensure full magnification repeatability, providing exceptional measurement accuracy with no need of post-zoom recalibration. TCDP optics can fit any camera up to 2/3" format, they can be mounted on CMHO clamping mechanics and paired with LTCLHP collimated illuminators as well as LTRN ring illuminators designed for standard TC series.

### Application examples



TCDP 2X 096 imaging an electronic board with two different cameras.



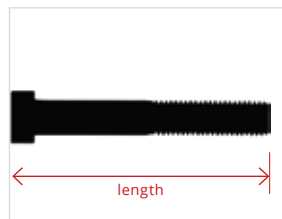
TCDP 4X 144 imaging a screw with two different cameras.



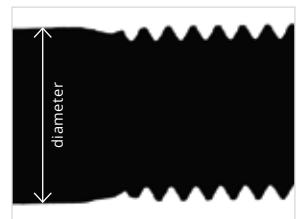
Full FOV image with lens lower magnification.



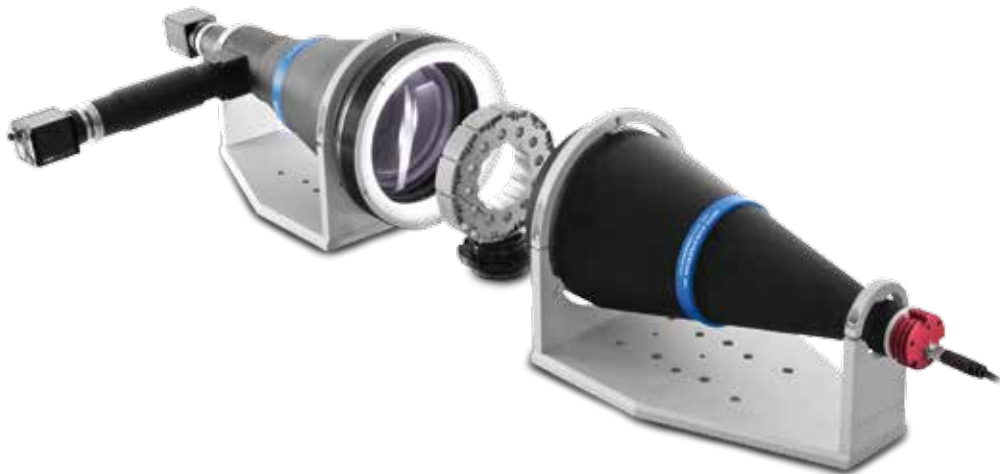
2x magnified image of the object central area.



Full FOV image with lens lower magnification.



4x magnified image of the object central area.



TCDP 4X 096 coupled with LTCLHP 096 telecentric illuminator and LTRN 096 ring light.

Part number	Mag. (x)	Detector type					Optical specifications						Dimensions		
		1/3"	1/2.5"	1/2"	1/1.8"	2/3" - 5 Mpx	WD (mm)	wF/#	Telecentricity typical (max) (deg)	Distortion typical (max) (%)	Field depth (mm)	CTF @70lp/mm (%)	Mount	Length (mm)	Diam. (width) (mm)
		w x h (mm x mm)	w x h (mm x mm)	w x h (mm x mm)	w x h (mm x mm)	w x h (mm x mm)									
<b>Object field of view (mm x mm)</b>															
TCDP 2X 096	0.093	51.4 x 38.5	61.0 x 45.8	68.5 x 51.4	76.3 x 57.5	90.4 x 75.6	278.6	8	< 0.06 (0.08)	< 0.04 (0.08)	77	> 30	C	337.0	143
	0.186	25.7 x 19.3	30.5 x 22.9	34.3 x 25.7	38.1 x 28.7	45.2 x 37.8		12	< 0.06 (0.10)	< 0.05 (0.08)	29	> 40			(175)
TCDP 4X 096	0.093	51.4 x 38.5	61.0 x 45.8	68.5 x 51.4	76.3 x 57.5	90.4 x 75.6	278.6	8	< 0.06 (0.08)	< 0.04 (0.08)	77	> 30	C	337.0	143
	0.374	12.8 x 9.63	15.3 x 11.4	17.1 x 12.8	19.1 x 14.4	22.6 x 18.9		12	< 0.06 (0.10)	< 0.07 (0.10)	7	> 40			(264)
TCDP 2X 120	0.072	67.0 x 50.3	79.6 x 59.7	89.4 x 67.0	99.5 x 75.0	117.9 x 98.7	334.5	8	< 0.07 (0.08)	< 0.04 (0.10)	131	> 30	C	423.0	180
	0.143	33.5 x 25.1	39.8 x 29.9	44.7 x 33.5	49.8 x 37.5	59.0 x 49.3		12	< 0.08 (0.10)	< 0.06 (0.08)	49	> 35			(194)
TCDP 4X 120	0.072	67.0 x 50.3	79.6 x 59.7	89.4 x 67.0	99.5 x 75.0	117.9 x 98.7	334.5	8	< 0.07 (0.08)	< 0.04 (0.10)	131	> 30	C	423.0	180
	0.286	16.8 x 12.6	19.9 x 14.9	22.3 x 16.8	24.9 x 18.7	29.5 x 24.7		12	< 0.08 (0.10)	< 0.05 (0.08)	12	> 35			(282)
TCDP 2X 144	0.061	78.6 x 58.9	93.3 x 70.0	104.8 x 78.6	116.7 x 87.9	138.3 x 115.7	396.0	8	< 0.05 (0.08)	< 0.04 (0.08)	180	> 30	C	483.0	200
	0.122	39.3 x 29.5	46.7 x 35.0	52.4 x 39.3	58.3 x 43.9	69.1 x 57.8		12	< 0.08 (0.10)	< 0.04 (0.07)	68	> 35			(204)
TCDP 4X 144	0.061	78.6 x 58.9	93.3 x 70.0	104.8 x 78.6	116.7 x 87.9	138.3 x 115.7	396.0	8	< 0.05 (0.08)	< 0.04 (0.08)	180	> 30	C	483.0	200
	0.244	19.6 x 14.7	23.3 x 17.5	26.2 x 19.6	29.2 x 22.0	34.6 x 28.9		12	< 0.08 (0.10)	< 0.05 (0.08)	17	> 35			(292)
TCDP 2X 192	0.046	104.9 x 78.6	124.6 x 93.4	139.8 x 104.9	155.7 x 117.3	184.5 x 154.4	526.9	8	< 0.06 (0.08)	< 0.05 (0.08)	320	> 30	C	623.0	260
	0.092	52.4 x 39.3	62.3 x 46.7	69.9 x 52.4	77.9 x 58.6	92.3 x 77.2		12	< 0.08 (0.10)	< 0.03 (0.05)	120	> 35			
TCDP 4X 192	0.046	104.9 x 78.6	124.6 x 93.4	139.8 x 104.9	155.7 x 117.3	184.5 x 154.4	526.9	8	< 0.06 (0.08)	< 0.05 (0.08)	320	> 30	C	623.0	260
	0.183	26.2 x 19.7	31.1 x 23.4	35.0 x 26.2	38.9 x 29.3	46.1 x 38.6		12	< 0.08 (0.10)	< 0.05 (0.08)	30	> 35			
TCDP 2X 240	0.037	130.8 x 98.1	155.4 x 116.6	174.4 x 130.8	194.3 x 146.3	230.2 x 192.6	492.8	8	< 0.03 (0.08)	< 0.04 (0.08)	498	> 30	C	776.0	322
	0.073	65.4 x 49.1	77.7 x 58.3	87.2 x 65.4	97.1 x 73.2	115.1 x 96.3		12	< 0.06 (0.10)	< 0.15 (0.20)	187	> 40			
TCDP 4X 240	0.037	130.8 x 98.1	155.4 x 116.6	174.4 x 130.8	194.3 x 146.3	230.2 x 192.6	492.8	8	< 0.03 (0.08)	< 0.04 (0.08)	498	> 30	C	776.0	322
	0.147	32.7 x 24.5	38.9 x 29.1	43.6 x 32.7	48.6 x 36.6	57.5 x 48.1		12	< 0.06 (0.10)	< 0.08 (0.10)	47	> 40			

- Working Distance: distance between the front end of the mechanics and the object. Set this distance within +/- 3% of the nominal value for maximum resolution and minimum distortion.
- Working F-number (wF/#): the real F-number of a lens when used as a macro.
- Maximum slope of principal rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement.

- At the borders of the field depth, the image can be still used for measurement, but to get a perfectly sharp image only half of the nominal field depth should be considered. Pixel size used for calculation is 5.5 µm.

# TCZR series

8x bi-telecentric zoom lenses with motorized control



## SOLUTION

Use the CMHO TCZR mechanical clamp for safe and accurate mounting.

**TCZR series** is a leading edge optical solution for imaging and measurement applications requiring both the flexibility of zoom lenses and the accuracy of fixed optics.

By means of a very accurate mechanism, these lenses ensure unequalled magnification, focusing and image center stability when switching from a magnification to another, thus avoiding recalibration at any given time.

Four different magnifications, featuring a total range of 8x, can be selected either by means of the onboard control keyboard or via computer through a specific remote control software.

Bi-telecentricity, high resolution and low distortion make these zooms able to perform the same measurement tasks as a fixed magnification telecentric lens.

## KEY ADVANTAGES

### Perfect magnification constancy

No need of re-calibration, after zooming.

### Perfect parfocality

No need of refocusing when changing magnification.

### Bi-telecentricity

Very accurate measurement is possible.

### Excellent image center stability

Each magnification maintains its FOV center.

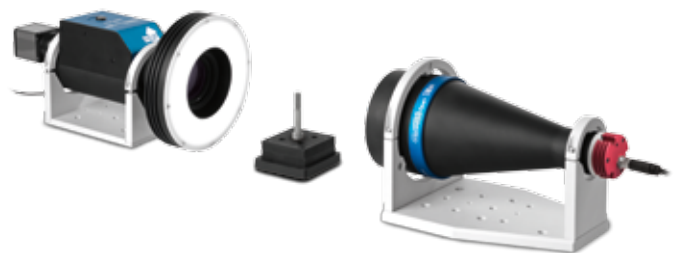
### Full motorization control

Zoom magnification can be set either manually or via software.

## MANUAL AND SETUP

Please refer to our website for the updated TCZR manual and for a complete technical documentation of the setup process.

[www.opto-engineering.com](http://www.opto-engineering.com)

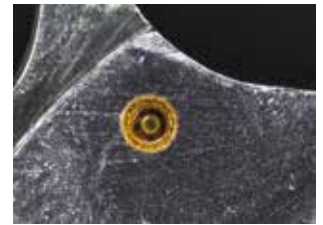
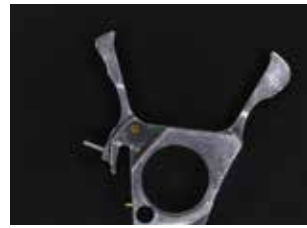
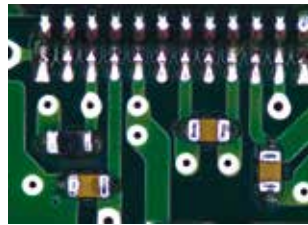


TCZR series can be coupled with LTCLHP and LTRN series illuminators and CMHO TCZR precision clamp.





## Application examples



Electronic board images taken with TCZR 036 at four different magnifications.

Hard disk arm images taken with TCZR 072 at four different magnifications.

Part number	Mag. (x)	Image circle Ø (mm)	Detector type					Optical specifications					Dimensions				
			1/3" w x h (mm x mm)	1/2.5" w x h (mm x mm)	1/2" w x h (mm x mm)	1/1.8" w x h (mm x mm)	2/3" - 5 Mpx w x h (mm x mm)	WD (mm)	wf/# 1	Telecentricity (deg) 2	Distortion (%)	Field depth (mm) 3	CTF @70lp/mm (%)	Mount	Length (mm)	Diam. (mm)	
<b>Object field of view (mm x mm)</b>																	
TCZR 036	0.250	10.0	19.2 x 14.4	22.8 x 17.1	25.6 x 19.2	28.5 x 21.5	33.7 x 28.2	74.0	16	< 0.05	< 0.04	< 0.05	11	> 40	C	212.0	56
	0.500		9.60 x 7.20	11.4 x 8.50	12.8 x 9.60	14.2 x 10.7	16.8 x 14.1					< 0.04	2.8	> 35			
	1.000		4.80 x 3.60	5.70 x 4.20	6.40 x 4.80	7.10 x 5.30	8.40 x 7.00					< 0.04	0.7	> 40			
	2.000		2.40 x 1.80	2.80 x 2.10	3.20 x 2.40	3.50 x 2.60	4.20 x 3.50					< 0.08	0.2	> 35			
TCZR 072	0.125	10.0	38.4 x 28.8	45.6 x 34.2	51.2 x 38.4	57.0 x 49.0	67.6 x 56.5	157.8	16	< 0.05	< 0.08	< 0.10	45	> 35	C	279.7	99
	0.250		19.2 x 14.4	22.8 x 17.1	25.6 x 19.2	28.5 x 21.5	33.7 x 28.2					< 0.08	11	> 40			
	0.500		9.60 x 7.20	11.4 x 8.50	12.8 x 9.60	14.2 x 10.7	16.8 x 14.1					< 0.05	2.8	> 40			
	1.000		4.80 x 3.60	5.70 x 4.20	6.40 x 4.80	7.10 x 5.30	8.40 x 7.00				< 0.07	0.7	> 35				

1 Working F-number (wf/#): the real F-number of a lens when used as a macro. Lenses with smaller apertures can be supplied on request.  
 2 Maximum slope of principal rays inside the lens: converted in milliradians, it gives the maximum measurement error for any millimeter of object displacement.

3 At the borders of the field depth, the image can be still used for measurement, but to get a perfectly sharp image only half of the nominal field depth should be considered. Pixel size used for calculation is 3.9 µm.

# MCZR series

4x macro revolver with motorized control



### KEY ADVANTAGES

**Perfect magnification costancy**

No need of re-calibration after zooming.

**Perfect parfocality**

No need of refocusing when changing magnification.

**Excellent image center stability**

Each magnification maintains its FOV center.

**Full motorized control**

Zoom magnification can be set either manually or via software.

### MANUAL AND SETUP

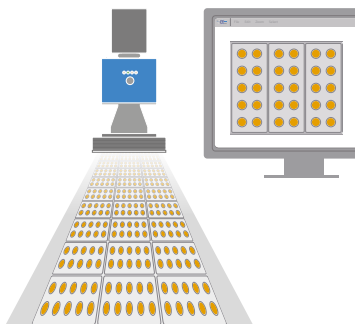
Please refer to our website for the updated MCZR manual and for a complete technical documentation of the setup process.

[www.opto-engineering.com](http://www.opto-engineering.com)

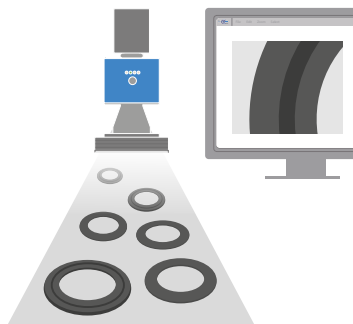
**MCZR series** are multiple-magnification optical systems which combine high resolution imaging with the flexibility of object format changing. Unlike conventional zoom systems, MCZR have been specifically designed to work as **macro** lenses while the optical system ensures the same optical performances of very high-resolution fixed focal lenses.

The device can be both automatically and manually set to one of the four available magnifications; this optomechanical solution ensures that both magnification and image centering are maintained when returning to a specific configuration. All of these features make these optical products perfect for all those on-line applications requiring frequent changes of format and high quality images all in one lens.

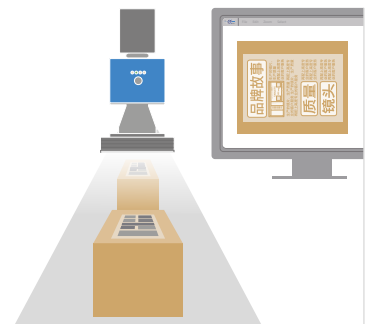
### Application examples



Quality inspection of different sized objects



Quality inspection o-ring/gaskets



Package inspection



Envelope barcode identification.

Gasket inspection.

Part number	Mag. (x)	Image circle Ø (mm)	Detector type					Optical specifications					Dimensions			
			1/3" w x h (mm x mm)	1/2.5" w x h (mm x mm)	1/2" w x h (mm x mm)	1/1.8" w x h (mm x mm)	2/3" - 5 Mpx w x h (mm x mm)	WD (mm)	F/#	(wF/#) 1	Distortion (%)	Field depth (mm) 2	CTF @50lp/mm (%)	Mount	Length (mm)	Width x Height (mm x mm) 3
<b>Object field of view (mm x mm)</b>																
MCZR 033-008	0.083	10.0	57.7 x 43.3	68.6 x 51.4	77.0 x 57.7	85.7 x 64.6	101.6 x 85.0	208.4	4.6	(5)	< 0.2	18	> 40	C	146.4	98.1 x 91.9
	0.167		28.8 x 21.6	34.2 x 25.7	38.4 x 28.8	42.8 x 32.2	50.7 x 42.4		4.3		< 0.1	4.5	> 50			
	0.250		19.2 x 14.4	22.8 x 17.1	25.6 x 19.2	28.5 x 21.5	33.8 x 28.3		4.0		< 0.05	2	> 60			
	0.333		14.4 x 10.8	17.1 x 12.8	19.2 x 14.4	21.4 x 16.1	25.4 x 21.2		3.8		< 0.05	1.1	> 60			
MCZR 025-006	0.063	10.0	76.7 x 57.5	91.1 x 68.3	102.3 x 76.7	113.9 x 85.8	134.9 x 112.9	275.9	4.7	(5)	< 0.2	30	> 50	C	149.9	98.1 x 91.9
	0.125		38.3 x 28.7	45.5 x 34.1	51.0 x 38.3	56.8 x 42.8	67.3 x 56.3		4.4		< 0.1	8	> 50			
	0.188		25.5 x 19.2	30.3 x 22.8	34.1 x 25.5	37.9 x 28.6	44.9 x 37.6		4.2		< 0.05	3.5	> 60			
	0.251		19.1 x 14.4	22.7 x 17.1	25.5 x 19.1	28.4 x 21.4	33.7 x 28.2		4.0		< 0.05	1.9	> 50			
MCZR 018-004	0.047	10.0	102.3 x 76.7	121.5 x 91.1	136.4 x 102.3	151.9 x 114.4	179.9 x 150.5	384.8	4.8	(5)	< 1	55	> 40	C	154.5	98.1 x 91.9
	0.094		51.0 x 38.3	60.6 x 45.5	68.1 x 51.0	75.8 x 57.1	89.8 x 75.1		4.6		< 0.2	14	> 40			
	0.141		34.1 x 25.5	40.5 x 30.3	45.4 x 34.1	50.6 x 38.1	59.9 x 50.1		4.4		< 0.1	6	> 60			
	0.188		25.5 x 19.1	30.3 x 22.7	34.0 x 25.5	37.9 x 28.6	44.9 x 37.6		4.2		< 0.05	3.5	> 60			
MCZR 014-003	0.035	10.0	137.5 x 103.1	163.4 x 122.5	183.4 x 137.5	204.2 x 153.8	242.0 x 202.4	532.3	4.8	(5)	< 1	100	> 40	C	154.7	98.1 x 91.9
	0.070		68.6 x 51.5	81.5 x 61.2	91.5 x 68.6	101.9 x 76.8	120.8 x 101.0		4.7		< 0.2	25	> 40			
	0.105		45.8 x 34.4	54.4 x 40.8	61.1 x 45.8	68.0 x 51.2	80.6 x 67.4		4.5		< 0.1	11	> 60			
	0.140		34.3 x 25.8	40.8 x 30.6	45.8 x 34.3	51.0 x 38.4	60.4 x 50.5		4.4		< 0.05	6	> 60			

1 F/# = F-number, wF/# = Working F-number, the real F-number of a lens when used as a macro.

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

2 At the borders of the field depth the image can be still used for measurement but, to get a perfectly sharp image, only half of the nominal field depth should be considered.

# The perfect solution for machine-vision inspection challenges.



One of the most recurring demands of the machine vision market is to be able to view every surface of an object with as few cameras as possible. This request is becoming more and more common in a variety of market areas, like the beverage, pharmaceutical and automotive industries.

**Opto Engineering designed these incredible optical solutions:**

just one camera shot is enough to capture the top and side views of an object or the bottom and inside views of an holed object.

**Most of these special optics are unique and patented by Opto Engineering:**

their names are registered trademarks and you will not find similar products on the market featuring the same build quality and the same optical performances.

---





360° view optics

# PC series

Pericentric lenses for 360° top and lateral view with just one camera



#### KEY ADVANTAGES

##### Just one camera

No need for multiple cameras placed around and over the object.

##### Fast image analysis

No image matching software is needed as the picture is not segmented.

##### Single point of view

No perspective effects typical of multi-image systems.

##### Smooth on-line integration

Inspected parts pass unobstructed in the free space below the lens.

**PC pericentric lenses** are unique optical systems designed to perform a complete inspection of an object up to 60 mm quickly and reliably: just one camera acquisition is enough to capture **the top and lateral faces** of an object.

Thanks to this innovative design there is no need to over-complicate the inspection setup with the use of additional mirrors, while delivering the magnification and field depth required to acquire the entire object volume.

The term pericentric comes from the specific path of the light rays: the resulting image shows the lateral views wrapped around the top face, which makes PC series ideal for cylindrical objects, very common in the beverage and pharmaceutical industry.

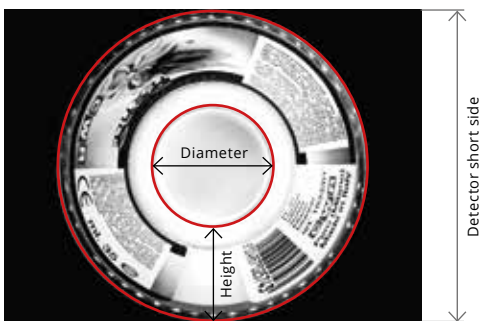
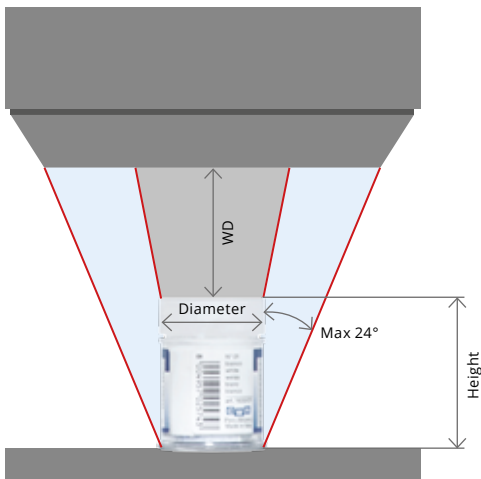
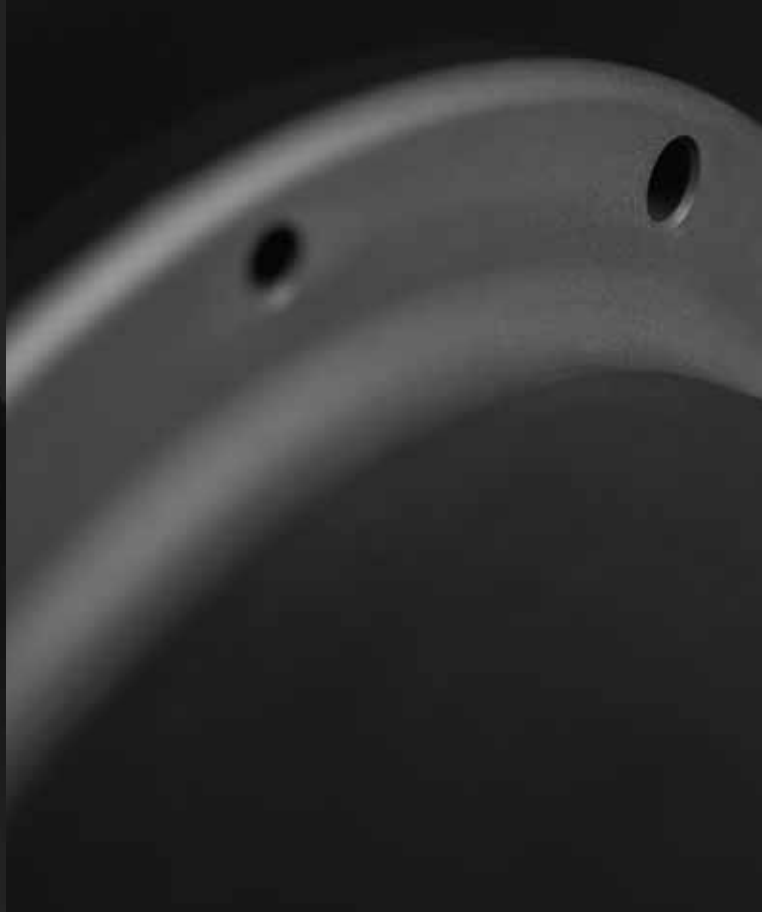
Classic application examples include bottleneck threads inspection and data matrix reading - the code will always be properly imaged, no matter the facing direction.

#### Sample images taken with PC optics



#### SETUP

Please refer to our website for setup instructions.  
[www.opto-engineering.com](http://www.opto-engineering.com)



$$r (\%) = \frac{\text{Side view height (px)}}{\text{Detector short side (px)}} * 100$$



Unwrapped image

**PC optics** are designed to work with 1/3", 1/2" and 2/3" detectors. The choice of such detectors ensures the most appropriate optical magnification factor to achieve the field depth required by high resolution 3D pericentric imaging.

The image of the top of the object and its sides are inscribed into the short side of the camera detector.

The smaller the object diameter, the larger the object height which can be inspected, while thin objects can be inspected over a larger diameter.

The tables below show possible combinations of object diameters and heights along with the appropriate working distance and recommended F-number; the "r" parameter for each configuration is also listed.

The "r" parameter is the ratio between the side view height (the circular crown thickness) and the detector short side. It provides information about side view resolution. The higher "r", the higher the resolution that can be achieved in the side view.

# PC series

Pericentric lenses for 360° top and lateral view with just one camera



### EXTENDED RANGE

Compact PC xx030XS lenses for inspection of objects with diameter down to 7.5 mm.

Now also available for high resolution 2/3" detectors.

Part number		PC 13030HP	PC 12030HP	PC 13030XS	PC 12030XS	PC 23030XS
<b>Detector type</b>		1/3"	1/2"	1/3"	1/2"	2/3"
<b>Field of view</b>	<b>(diam x height)</b>					
Min	(mm x mm)	20 x 60	20 x 60	7.5 x 5	10 x 5	15 x 5
Typical	(mm x mm)	30 x 30	30 x 30	30 x 30	30 x 30	30 x 30
Max	(mm x mm)	60 x 20	60 x 20	55 x 20	55 x 15	55 x 12
<b>Optical specifications</b>						
Wavelength range	(nm)	450 .. 650	450 .. 650	450 .. 650	450 .. 650	450 .. 650
Working distance	(mm)	20 .. 80	20 .. 80	20 .. 85	20 .. 80	20 .. 80
CTF @ 50 lp/mm	(%)	> 30	> 25	> 40	> 30	> 25
F/#		4-16	4-16	4-16	4-16	4-16
<b>Mechanical specifications</b>						
Diameter (max)	(mm)	197	197	116	116	116
Length	(mm)	448	448	378	378	378
Weight	(g)	6800	6800	2950	2950	2950
Mount		C	C	C	C	C







**Field of view selection chart**

**PC 13030HP field of view**

Diam.	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r
(mm)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)
20	7	79	16	10	13	79	8	20	20	65	16	26	30	61	12	30	40	55	14	34	60	25	16	37
25	8	71	4	17	17	63	12	21	25	55	16	26	38	40	14	30	50	30	16	30				
30	10	65	4	13	20	55	8	19	30	42	12	25	45	35	12	29								
40	13	52	6	12	27	43	12	20	40	27	12	25												
50	17	36	6	13	33	20	8	15																
60	20	23	4	11																				

**PC 12030HP field of view**

Diam.	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r
mm	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)
20	7	76	16	10	13	70	24	15	20	65	24	28	30	55	16	32	40	45	24	32	60	27	24	35
25	8	72	12	11	17	63	12	18	25	54	16	28	38	40	16	32	50	29	16	32				
30	10	66	12	11	20	56	12	19	30	45	16	25	45	30	16	35								
40	13	54	6	11	27	36	16	20	40	27	24	23												
50	17	32	12	13	33	20	16	18																
60	20	22	12	11																				

**PC 13030XS field of view**

Diam.	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r
(mm)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)
7.5	5	85	16	19																				
10	5	84	16	14	10	77	16	20																
15	5	75	6	10	10	70	8	15	15	65	16	20	20	60	16	22	25	54	16	24	32	45	16	28
20	10	62	8	12	20	52	14	18	30	42	14	22	40	32	16	26								
25	5	62	6	6	15	52	12	15	25	42	12	19	35	32	12	24	45	22	12	27				
30	10	52	4	9	20	42	8	17	30	32	8	20	40	22	16	23	50	12	16	27				
35	5	48	4	7	15	38	4	12	25	28	8	16	35	18	8	20	42	10	12	22				
40	10	38	4	9	20	28	4	13	30	20	8	16	37	10	16	19								
45	5	34	6	7	15	30	6	9	25	20	8	12	35	10	16	15								
50	5	25	4	8	15	20	6	9	25	10	8	13												
55	10	20	6	6	20	10	8	10																

**PC 12030XS field of view**

Diam.	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r
mm	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)
10	5	82	18	18												
15	5	73	16	14	15	63	16	23								
20	5	66	16	9	10	61	16	14	20	51	16	22				
25	10	56	12	10	20	46	16	18	30	36	16	23				
30	10	48	8	10	20	38	16	15	30	28	16	20	40	18	16	24
35	5	48	12	5	15	38	12	12	25	28	12	17	35	18	16	21
40	10	37	14	8	20	27	16	13	30	17	16	17				
45	10	32	8	7	20	22	8	12	30	12	16	16				
50	10	25	10	7	20	15	16	12								
55	5	23	16	5	15	13	16	10								

**PC 23030XS field of view**

Diam.	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r	Height	WD	F/#	r
mm	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)	(mm)	(mm)		(%)
15	5	78	8	12	15	68	16	19								
20	10	62	16	12	20	52	16	18								
25	10	57	8	10	20	47	12	16	30	37	16	21				
30	15	45	8	12	25	35	12	17	35	25	16	20	45	13	16	23
35	10	45	16	8	15	40	16	11	25	30	16	15				
40	10	38	12	8	20	30	12	13	30	20	16	17				
45	10	33	16	7	20	23	16	11								
50	10	25	16	5	20	15	16	11								
55	12	12	16	6												

# PCCD series

Catadioptric lenses for 360° top and lateral view with just one camera



**KEY ADVANTAGES**

- 360° imaging of small objects**  
Parts down to 7.5 mm in diameter can be imaged.
- Extra wide lateral viewing angle**  
Object sides viewing angle approaches 45°.
- Compactness**  
The lens can be easily integrated in any system.
- Perfect chromatic correction**  
For RGB camera applications and color inspection.

**EXTENDED RANGE**

PCCD 023 available for high resolution 2/3" detectors.

**ACCESSORY**

PCCDLFAT Field of view extender for inspection of objects with diameter > 25 mm.

**PCCD series** are catadioptric lenses exclusively developed and produced by Opto Engineering to enable the 360° side view imaging of small objects. Their innovative optical design, based on a catadioptric system, makes it possible to image objects with diameters as small as 7 mm.

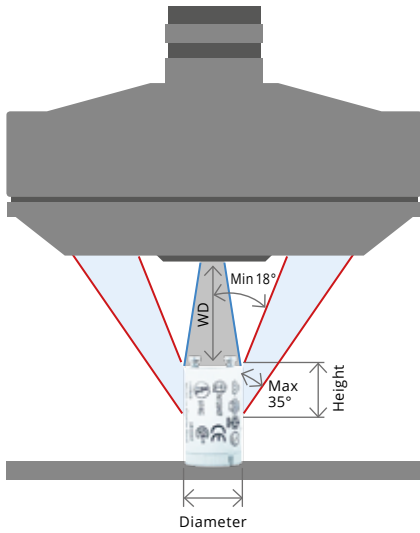
The sides of the object are imaged through the catadioptric system, while the top surface is directly imaged onto the center of the detector. The compactness and high resolution performances of

these lenses make them the perfect choice for the inspection of components like pharmaceutical containers, plastic caps, pre-forms, bottle necks, screws and other threaded objects. PCCD series can work either with 1/2", 1/3" and 2/3" detectors. The sides of the object being inspected are observed over a wide view angle, approaching 45° at its maximum; this feature makes it possible to inspect complex object geometries under a convenient perspective.

Part number		PCCD 013	PCCD 012	PCCD 023
<b>Detector type</b>		1/3"	1/2"	2/3"
<b>Field of view</b>	<b>(diam x height)</b>			
Min	(mm x mm)	7.5 x 5	7.5 x 5	7.5 x 5
Typical	(mm x mm)	15 x 10	15 x 10	15 x 10
Max	(mm x mm)	25 x 17	25 x 17	25 x 17
Extended with PCCDLFAT	(mm x mm)	35 x 26	35 x 26	35 x 25
<b>Optical specifications</b>				
Wavelength range	(nm)	450 .. 650	450 .. 650	450 .. 650
Working distance	(mm)	28 .. 53	28 .. 53	24 .. 47
Working distance with PCCDLFAT	(mm)	5 .. 11	5 .. 11	5 .. 11
CTF @ 50 lp/mm	(%)	> 35	> 30	> 30
F/#		6 - 24	8 - 32	8 - 24
<b>Mechanical specifications</b>				
Diameter	(mm)	143	143	143
Length	(mm)	110.5	110.5	110.5
Weight	(g)	980	990	990
Mount		C	C	C

**Sample images taken with PCCD optics**

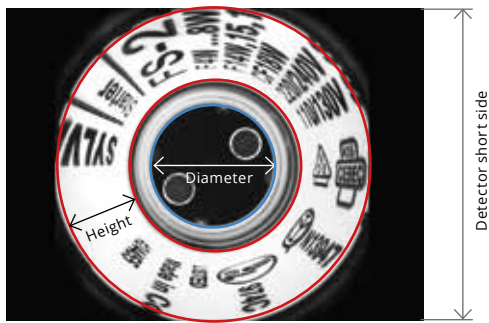




The image of the external walls of the object, captured through the catadioptric system, is inscribed into the short side of the camera detector within a circular crown. On the other hand, the top of the object is directly imaged onto the central part of the detector area: both the lateral and top view of the object are in perfect focus at the same time.

The tables show possible combinations of object diameters and heights along with the appropriate working distance and recommended F-number; the “c” parameter for each configuration is also listed.

The “c” parameter describes the dimension of the top view image: it is calculated as the ratio between the central top view diameter and the short side of the detector. The typical ratio between the object height and its diameter is 2/3 which means that, for a given object diameter (i.e. 15 mm), the recommended inspection height will be around 67% of the diameter (10 mm). However, this parameter can be modified to accommodate for different aspect ratios (up to 100%) by adjusting the lens working distance, focus and F-number.



$$c (\%) = \frac{\text{Top view diameter (px)}}{\text{Detector short side (px)}} * 100$$



Unwrapped image

### Field of view selection chart

#### PCCD 013 field of view

Diameter (mm)	Height (mm)	WD (mm)	F/#	c (%)
7.5	5.0	53	24	11
10	6.7	49	16	15
15	10.0	42	12	22
20	13.3	35	8	30
25	16.7	28	6	37

#### Extended FOV with PCCDLFAT

30	22	11	8	36
35	26	5	8	37

#### PCCD 012 field of view

Diameter (mm)	Height (mm)	WD (mm)	F/#	c (%)
7.5	5.0	53	32	13
10	6.7	49	24	17
15	10.0	42	16	25
20	13.3	34	12	33
25	16.7	28	8	42

#### Extended FOV with PCCDLFAT

30	22	11	8	37
35	26	5	8	37

#### PCCD 023 field of view

Diameter (mm)	Height (mm)	WD (mm)	F/#	c (%)
7.5	5.0	47	24	12
10	6.7	45	24	16
15	10.0	38	16	24
20	13.3	30	12	32
25	16.7	24	8	40

#### Extended FOV with PCCDLFAT

30	22	14	8	37
35	25	10	8	45

### PCCD accessories



**PCCDLFAT** is an accessory designed to extend the FOV of PCCD optics and inspect objects with even larger diameters (beyond 25 mm). This accessory can be easily mounted on PCCD optics by the user: simply remove the pre-assembled protective window and replace it with PCCDLFAT.



PCCD optics are complemented by a full set of accessories, including **CMHO PCCD**: dedicated clamping mechanics designed to securely hold catadioptric lenses. **LTRN series**: specific LED ring illuminators.

# PCHI series

Hole inspection optics for 360° inside view in perfect focus



## KEY ADVANTAGES

### Perfect focusing of holed objects

Both the walls and the bottom of a cavity are imaged in high resolution.

### Cavity inspection from the outside

No need to put an optical probe into the hole.

### Very high field depth

Objects featuring different shapes and dimensions can be imaged by the same lens.

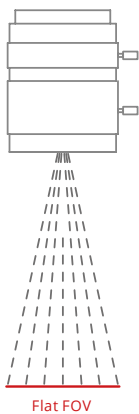
### Wide viewing angle

Sample surfaces are acquired by the lens under a convenient perspective to clearly display their features.

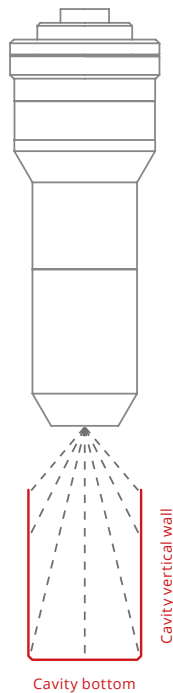
**PCHI optics** have been developed by Opto Engineering to enable the perfect viewing of holed objects, cavities and containers. Unlike common optics or so called “pinhole lenses” which can only image flat fields of view, hole inspection optics are specifically designed to image both the bottom of a hole and its vertical walls.

Thanks to the large view angle (>82°) and innovative optical design, these lenses are compatible with a wide range of object diameters and thicknesses. Hole inspection optics are the perfect solution to inspect a variety of different object shapes such as cylinders, cones, holes, bottles or threaded objects.

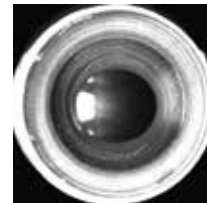
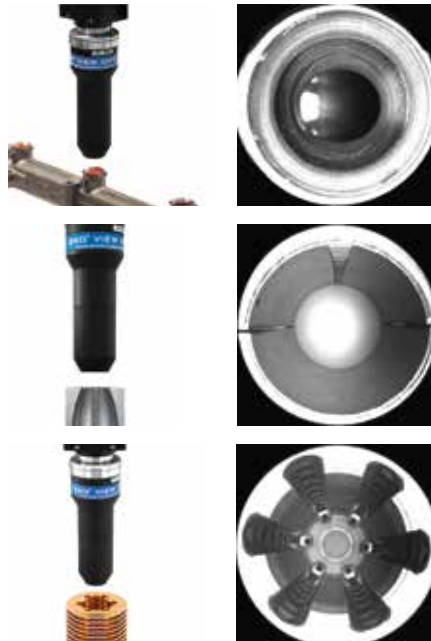
Common lens



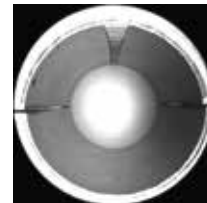
Hole inspection optics



## Sample images taken with PCHI optics



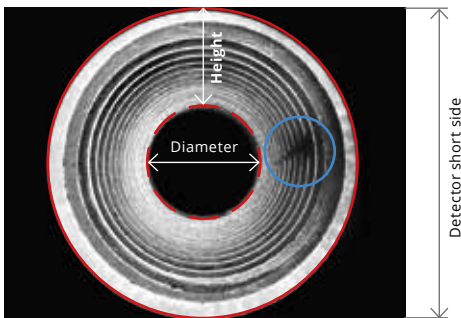
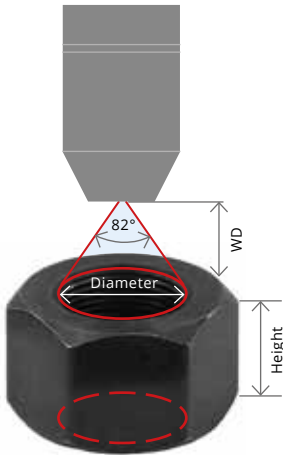
Perfect focusing is maintained throughout the entire depth of a hole.



Conical cavity inspection is possible from both sides.



Square, polygonal or irregular cross section objects can be inspected.



$$r (\%) = \frac{\text{Side view height (px)}}{\text{Detector short side (px)}} * 100$$



Unwrapped image

Part number	PCHI 013	PCHI 012	PCHI 023
<b>Detector type</b>	<b>1/3"</b>	<b>1/2"</b>	<b>2/3"</b>
<b>Field of view 1</b>	<b>(diam x height)</b>		
Min	(mm x mm)	10 x 10	10 x 10
Max	(mm x mm)	120 x 190	120 x 190
<b>Optical specifications</b>			
Wavelength range	(nm)	450 .. 650	450 .. 650
Working distance	(mm)	5 .. 62	5 .. 62
CTF @ 50 lp/mm	(%)	> 40	> 40
wF/# 2		4.7	5.8
<b>Mechanical specifications</b>			
Diameter	(mm)	28.0	28.0
Length	(mm)	102.0	104.0
Weight	(g)	250	250
Mount		C	C

- 1 Certain CS-mount cameras may affect PCHI 0xx range of focusing (especially for large diameters). Contact us to check compatibility with your specific camera.
- 2 Working F-number (wF/#): the real F-number of a lens when used as a macro.

#### EXTENDED RANGE

PCHI 023 now available for high resolution 2/3" detectors.

### Field of view selection chart

PCHI 013, PCHI 012 and PCHI 023 field of view

Hole diameter (mm)	High res. imaging		Normal res. imaging		WD (mm)
	Cavity height (mm)	r (%)	Cavity height (mm)	r (%)	
10	6	23.5	10	28	5
15	8.5	22.5	14.5	29	6.5
20	13	26.5	22	32.5	9
25	18	26	31	33	11
30	22	26	37	32	14
40	31	26.5	53	32	18
50	40	27	68	32	23
60	50	28.5	85	32.5	29
70	60	28	102	33	35
80	75	29.5	120	34	41
100	97	30	155	34.5	52
120	120	31	190	35	62

PCHI optics can image cavities whose diameters and thicknesses span over a wide range of values.

For a given hole diameter, the table on the left lists the maximum cavity height allowed for both high resolution imaging (small pixel sizes) and normal resolution imaging (>5 micron pixels) applications; the "r" ratio indicates how much of the detector area gets covered by the image of the hole inner walls.

The listed working distance values ensure that the object image is exactly inscribed into the short side of the detector, thus maximizing "r" ratio and image resolution.

# PCBP series

Boroscopic probes for panoramic cavity imaging and measurement from inside



## KEY ADVANTAGES

### Inspection of cavities from inside

Hidden internal features and defects are clearly viewed.

### High resolution

The catadioptric design enables the detection of tiny defects over a very wide view angle.

### Flaw detection

Coarse deformations revealed using direct illumination.

### Surface defect enhancement

Mixing direct and indirect illumination makes it possible to emphasize tiny and scarcely visible defects.

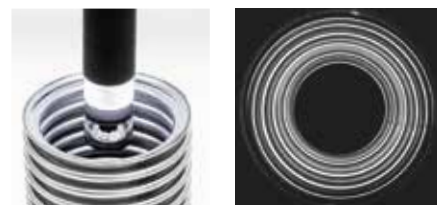
**PCBP probes** are used to inspect holed objects such as engine parts, containers and tubes whose hidden features can only be controlled by introducing a probe into the cavity. The catadioptric (refracting + reflecting) optical design ensures much higher resolution than fiber-based probes and enables a complete

360° inner View-throughout the entire cavity length. B Boroscopic probes are intended to be handled by a robot arm or S.C.A.R.A. in order to scan even the deepest cavities. Built-in illumination keeps the device very compact and makes it suitable for simple 3D applications by means of panoramic triangulation techniques. .

## Sample images taken with a PCBP optics



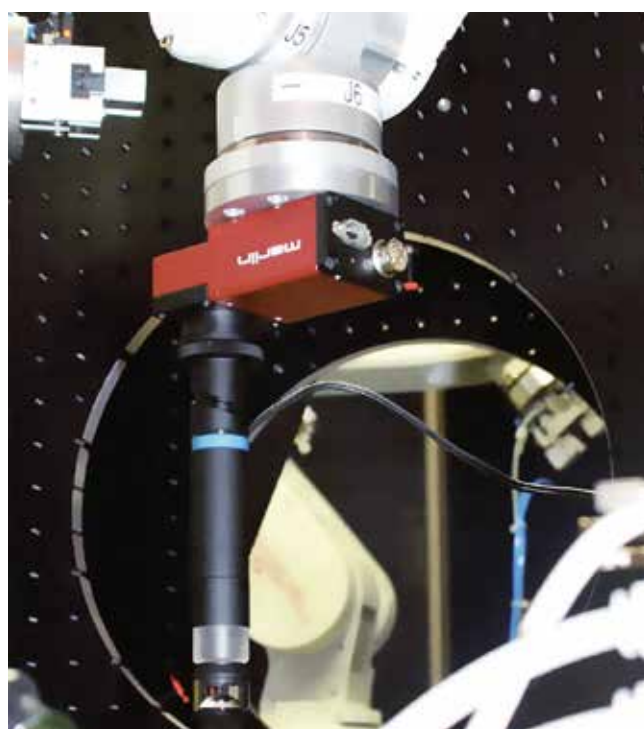
Inspection of holed parts of an engine.

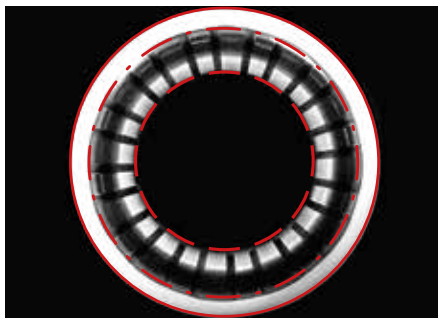
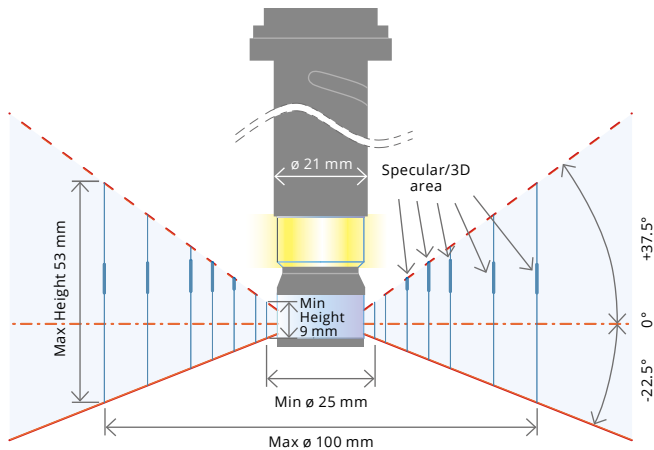


Tube scanning for integrity inspection.



Defect and impurities detection inside containers.





Unwrapped image

PCBP probes can image cavities whose diameter ranges from 25 mm to 100 mm and over: the table below shows the inspection range allowed.

Inspection area	
Diameter (mm)	Height (mm)
25	9
30	12
40	18
50	23
60	29
80	41
100	53

An integrated LED source illuminates the cavity both diffusely and directly (specular illumination). The diagram on the left shows the different illumination areas. The diffused illumination is used for defect detection and component inspection.

The direct/specular illumination can be efficiently used to check for surface deformation on metal and highly reflective objects as well as to measure the hole diameter.

The image of the cavity covers around 50% of the detector height; the continuous red line indicates the bottom view of the cavity (-22.5°), the dashed line shows the upper view (+37.5°) while the dashdotted line refers to the lateral view (0°).

Part number		PCBP 013	PCBP 012
<b>Detector type</b>		1/3"	1/2"
<b>Field of view</b>	<b>(diam x height)</b>		
Min	(mm x mm)	25 x 9	25 x 9
Max	(mm x mm)	100 x 53	100 x 53
<b>Optical specifications</b>			
Wavelength range	(nm)	450 .. 650	450 .. 650
Viewing angle	(deg)	60	60
CTF @ 50 lp/mm	(%)	> 25	> 20
F/#		14	16
<b>Mechanical specifications</b>			
Diameter	(mm)	21	21
Length	(mm)	167	137
Weight	(g)	113	92
Mount		C	C
<b>Electrical specifications</b>			
LED Voltage	(V)	16 .. 24	16 .. 24
LED Power	(W)	< 2.0	< 2.0



The LED illumination device is integrated into the unit. The optical tip of the probe **PCBPTIP** can be easily replaced in case of damage.



The best focus is achieved by means of a lockable focusing mechanism. Power supply cables exit the device nearby the C-mount.

# PCPW series

Polyview optics for multiple side views with one shot



**KEY ADVANTAGES**

**Just one camera**

No need for multiple cameras placed around and over the object.

**Wide viewing angles**

45° side view makes otherwise hidden features visible.

**Complete surface inspection**

Both inner and outer object surfaces can be imaged in one shot.

**Very high resolution**

Even the tiniest defects can be detected.

**PCPW optics** provide eight different views of the side and top surfaces of an object.

The wide perspective angle (45°) enables the inspection of the side features of an object (for example the threads of a screw or a nut) otherwise impossible to acquire with a single camera.

Both the external walls of an object and its top can be imaged at the same time, while internal surfaces of holed objects can be completely inspected from the outside. A combined view of the internal and external surfaces is possible and an image displaying both the inner walls and the bottom of a cavity can be obtained.

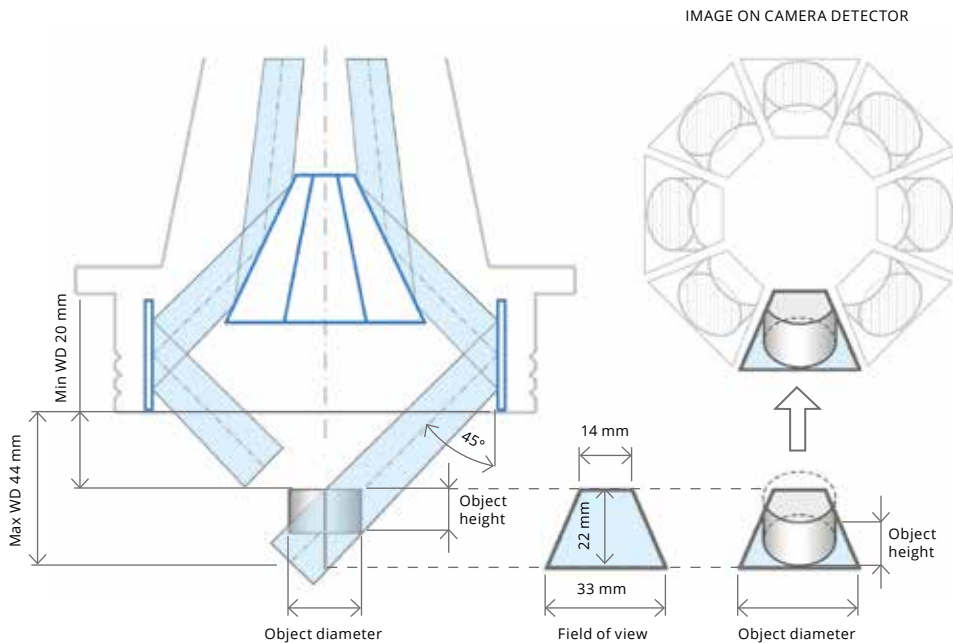
In addition to these unique features, PCPW optics also ensures excellent image resolution and image brightness.

**Sample images taken with PCPW optics**

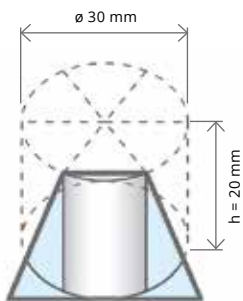


Part number		PCPW 013	PCPW 012	PCPW 023
<b>Detector type</b>		1/3"	1/2"	2/3"
<b>Max object diameter for SIDE inspection</b>				
Height 20 mm	(mm)	30	30	30
Height 5 mm	(mm)	50	50	50
<b>Max object diameter for SIDE + TOP inspection</b>				
Height 10 mm	(mm)	30	30	30
<b>Optical specifications</b>				
Wavelength range	(nm)	450 .. 650	450 .. 650	450 .. 650
Working distance	(mm)	20 .. 40	20 .. 40	20 .. 40
CTF @ 50 lp/mm	(%)	> 60	> 50	> 40
F/#		4-12	6-16	8-16
<b>Mechanical specifications</b>				
Diameter	(mm)	140	140	140
Length	(mm)	224	224	224
Weight	(g)	990	990	990
Mount		C	C	C

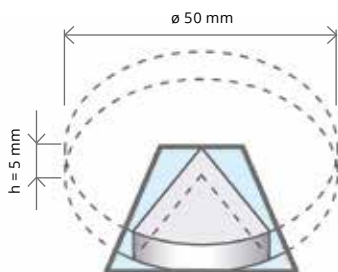




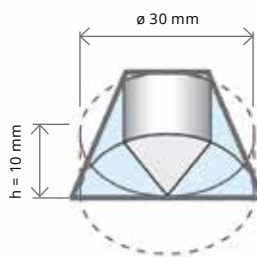
The diagram shows how PCPW optics image a cylindrical object. The object is observed at a 45° viewing angle, from eight different points of view. Eight different trapezoidal fields of view are obtained: all the object features included in such a trapezoid will be imaged on the corresponding image portion. 45° viewing angle allows for imaging both the sides of a cylindrical object and its top; if the object is a hollow cylinder (hole or cavity), the inner wall of the cavity will be imaged instead of the top, thus enabling both outer and inner sides inspection.



When the object height is maximum (20 mm) up to 30 mm diameter objects can be inspected.



Up to 50 mm diameter objects can be inspected, provided their thickness doesn't exceed 5 mm.



Combined view of both the inner sides and the bottom of a cavity is possible when objects are up to 30 mm diameter and 10 mm height.

### Maximum field of view

In order to perform a complete 360° inspection, each of the eight image portions should image at least 1/6 of the cylindrical surface; this condition ensures a good overlapping between two different lateral views, since part of the object features will be shared by two neighboring image portions.

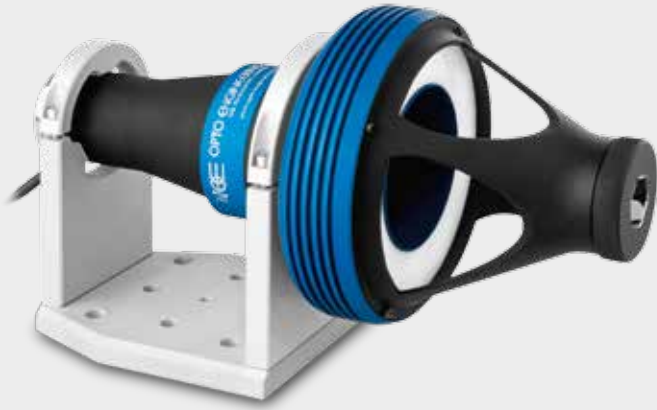
Part number		LTRN 050 W 45
Light color		white, 6300 K
<b>Dimensions</b>		
Outer diameter	(mm)	54.0
Inner diameter	(mm)	15.2
Height	(mm)	18.0
Weight	(g)	30.0
Mount		threaded retaining ring
Voltage	(V, DC)	24
Power	(W)	3
Compatible PC lenses		PCPW 0xx, PCHI 0xx
Other compatible lenses		TC 23 00x, MC3-03X



**LTRN 050 W 45** is a small LED ring illuminator compatible with different products and suitable for a variety of inspections. This illuminator is also perfectly suitable for illuminating the inner sides of a cavity imaged by a Polyview lens; the illuminator flange is threaded to fit PCPW series inner mounting interface.

# PCMP series

Micro-polyview optics for 3D measurement and imaging of small parts



## KEY ADVANTAGES

### Small parts lateral imaging

Inspection of objects whose size ranges from 1 to 10 mm.

### Measurement capability

The top and the lateral views show the same magnification.

### High field depth

The top and the lateral views are imaged without significant defocusing.

**PCMP optics** are 3D, multi-image lenses designed to completely measure and inspect objects whose dimensions range from 1 to 10 mm, such as electronic components, solder paste and micro-mechanics. Six different lateral views are provided by an array of mirrors interfaced to a bi-telecentric lens; the top of the object is directly imaged at the center of the field of view.

The lateral views feature exactly the same magnification and the images remain in perfect focus even when the object is displaced from its nominal position. All the views can be used to precisely measure the dimension of components from different angles. PCMP series integrates LED illumination with the optimal lighting geometry for this optical configuration.

## CUSTOM FEATURES

- different number of views
- different view angles
- asymmetric or special mirror arrays can be supplied upon request.

Part number		PCMP 012	PCMP 023
<b>Detector type</b>		1/2"	2/3"
<b>Max object inspection height</b>			
With diameter 2.5 mm		6	6
With diameter 5 mm		4.5	4.5
With diameter 7.5 mm		3	3
With diameter 10 mm		1	1
<b>Optical specifications</b>			
Wavelength range	(nm)	450 .. 650	450 .. 650
Working distance	(mm)	1.5 .. 5	1.5 .. 5
CTF @ 50 lp/mm	(%)	> 40	> 40
wF/# <sup>1</sup>		8	8
<b>Mechanical specifications</b>			
Diameter	(mm)	119	119
Length	(mm)	262	262
Weight	(g)	980	980
Mount		C	C
<b>Electrical specifications</b>			
Illuminator voltage	(V, DC)	24	24
Illuminator power	(W)	18	18

The suggested working distance ranges from 1.5 to 5 mm. The best focusing can be achieved by adjusting the number of spacers in the C-mount interface or by vertically positioning the illuminator+mirror assembly.

The image orientation phase can be adjusted by simply rotating the mirror cage or the whole assembly.

The top and side views show exactly the same magnification; however the side views appear to be compressed because of the perspective angle. Thanks to telecentric imaging such compression is purely linear and therefore very easy to compensate.

<sup>1</sup> Working F-number (wF/#): the real F-number of a lens when used as a macro.

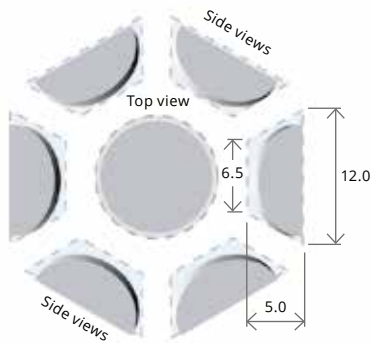
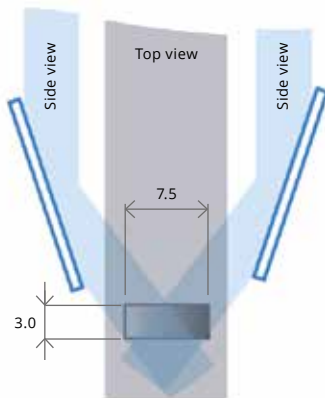
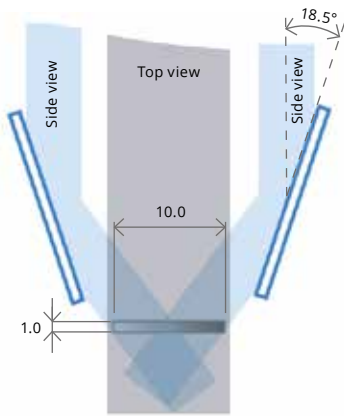
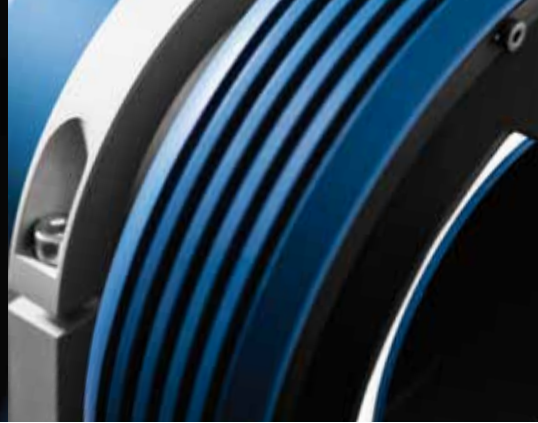
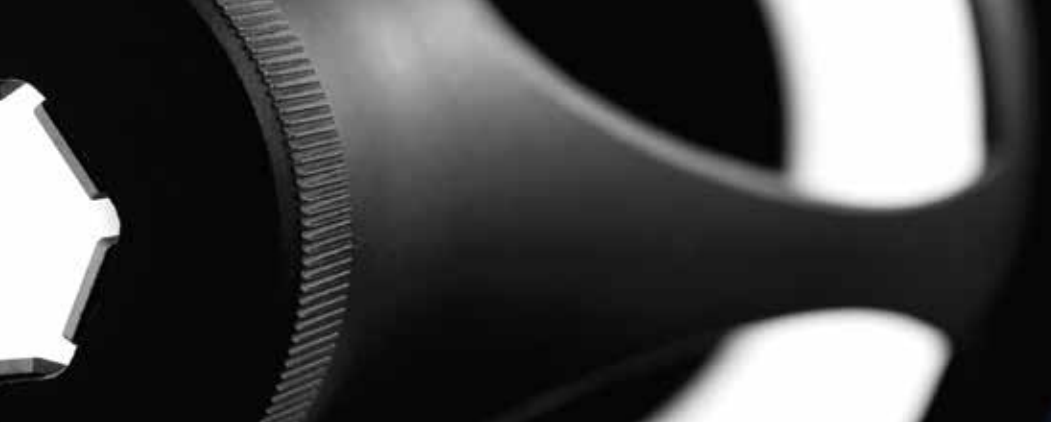


IMAGE ON CAMERA DETECTOR

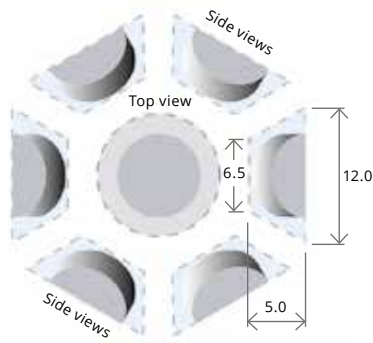


IMAGE ON CAMERA DETECTOR

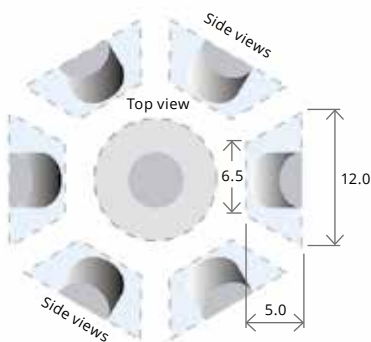
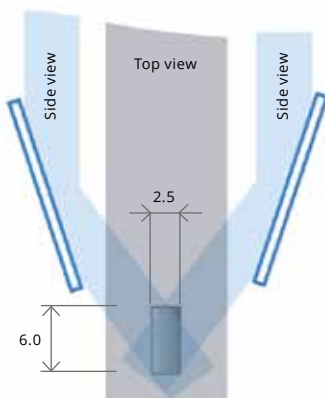
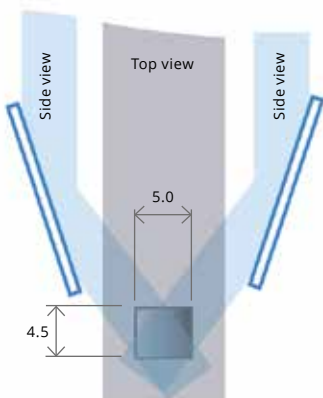


IMAGE ON CAMERA DETECTOR

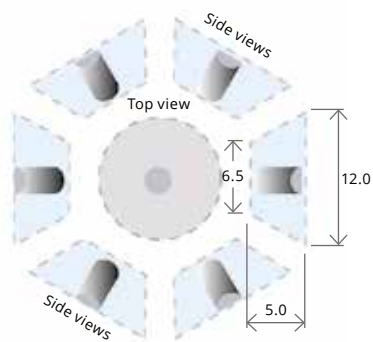


IMAGE ON CAMERA DETECTOR

## Application examples

### Mechanical components inspection

Thread integrity, pitch and diameter can be verified and measured.



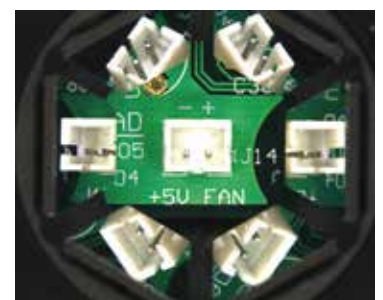
### SMD components inspection

Integrated circuit position, rotation, pin integrity and bonding can be checked.



### Electronic connector check

Presence/absence, alignment and length of pins can be precisely measured.



# TCCAGE series

Bi-telecentric system for multiple side imaging and measurement at 90°



## KEY ADVANTAGES

### 90° lateral imaging

The four orthonormal views allow visualization of object features that are hidden when looked at from the top.

### Long and thin object inspection

The characteristic aspects ratio of the four image segments perfectly fits long and thin objects.

### Built-in illumination

The device also incorporates two different light sources, for back and direct illumination.

### Suitable for measurement

The telecentric optics makes this module perfect for any multiple-measurement application.

**TCCAGE** is an integrated optomechanical system designed to fully inspect and measure parts from their side without any need of rotation. Four orthonormal views of an object are provided by a bi-telecentric lens through an array of mirrors.

The optical path is designed to set the displacement angle between the views is exactly 90°; this optical layout ensures complete coverage of the object lateral surface.

Furthermore, telecentric imaging makes the system insensitive to off-centered parts and therefore suitable for measurement applications.

TCCAGE is the perfect solution for inspecting parts whose features would be hidden when looked at from the top and for all those applications where an object must be inspected or measured from different sides. Two different illumination devices are built into the system to provide either backlight or direct part illumination.

## NEW TCCAGEXX096 AVAILABLE

New robust mechanical design with precise mirror alignment.

New back-light featuring highly transmissive diffuser and more powerful light source.

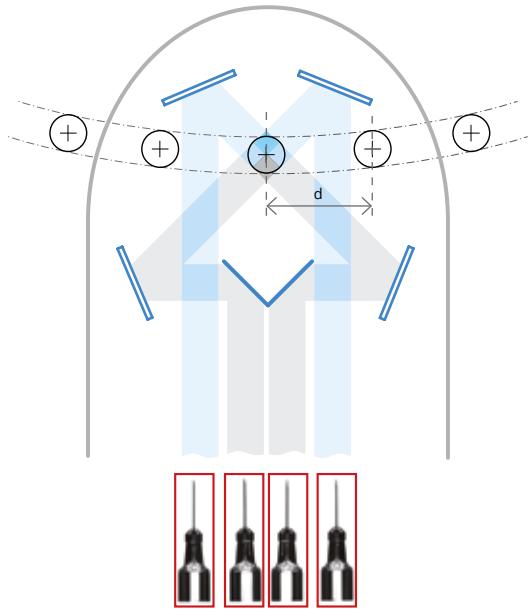
4.5 times higher light output.

Greater uniformity of backlit images thanks to the new diffuser.

Easy removal of back-light + heatsink group.

Part number		TCCAGE 12048	TCCAGE 23048	TCCAGE 12096	TCCAGE 23096
<b>Detector type</b>		<b>1/2"</b>	<b>2/3"</b>	<b>1/2"</b>	<b>2/3"</b>
<b>Max object diameter</b>	(mm)	8	8	16	16
<b>Max object height</b>	(mm)	32	32	68	68
<b>Optical specifications</b>					
Wavelength range	(nm)	450 .. 650	450 .. 650	450 .. 650	450 .. 650
CTF @ 50 lp/mm	(%)	> 40	> 40	> 40	> 40
wF/# <sup>1</sup>		8	8	8	8
<b>Mechanical specifications</b>					
Width	(mm)	111	111	179	179
Length	(mm)	192.8	192.8	347	347
Height	(mm)	248	248	405	424
Weight	(g)	2700	2700	9111	9154
Mount		C	C	C	C
<b>Electrical specifications</b>					
Ring illumination voltage	(V, DC)	24	24	24	24
Ring illumination power	(W)	3	3	3	3
Back illumination voltage	(V, DC)	24	24	24	24
Back illumination power	(W)	9	9	15	15

<sup>1</sup> Working F-number (wF/#): the real F-number of a lens when used as a macro.



**Sample images taken with TCCAGE**



**Working principle**

A bi-telecentric lens observes the object from four different positions through a mirror assembly, ensuring that the optical path is the same for all four view points.

The four views are equally spaced every 90° and partially overlapped, obtaining complete coverage of the object lateral surfaces.

The system can thus tolerate off-centered components without any significant decay of the image quality thanks to the telecentric optics, which ensures that magnification is maintained in each image segment. The system is designed so as to allow components to pass unobstructed through the mirror cage, for in-line applications.

When TCCAGE system is used for in-line inspection, consider the following minimum distance “d” between two consecutive objects in order to avoid image overlapping

TCCAGE xx048	$d \text{ (mm)} \cong 25 + \varnothing_{\text{object}} / 2$
TCCAGE xx096	$d \text{ (mm)} \cong 50 + \varnothing_{\text{object}} / 2$

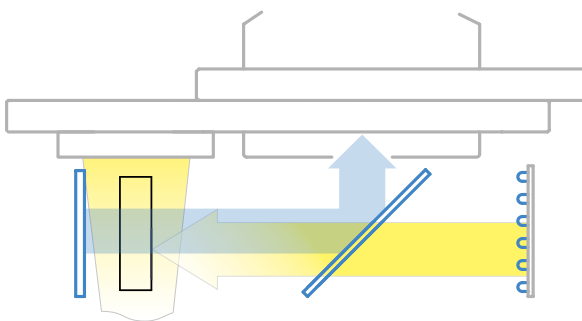
**Illumination geometry**

TCCAGE series integrate both direct and backlight illumination devices. Direct illumination (yellow cone in the drawing) is provided by a ring illuminator placed on the top of the part that can be used to enhance surface defects.

Back lighting (indicated by the yellow arrow) is obtained by means of a diffusive source which illuminates the object through the mirror system; this type of illumination is suggested for measurement purposes or to inspect transparent objects.

**Additional port**

TCCAGE is provided with an extra port placed right above the object. This port can be used to inspect the top of the part using an additional lens and camera system (for example a PCHI hole inspection lens, a macro or TC lens). The port can also accommodate other types of illuminators.



A complete array of products  
dedicated to close-range inspection.

**Macro lenses are Opto Engineering answer  
to the need for macro-based accurate imaging.**

While not suited to measurement applications  
- due to their non-telecentric nature which allows  
perspective bias - **they can perform close-range inspections  
very effectively with impressive optical performance  
in terms of resolution and lack of distortion.**

Like all our products, these optics are built to be deployed  
in a real-world environment: their compact form factor,  
flexible design, optical capabilities and excellent value make  
the Opto Engineering macro lenses an optimal component  
of a wide range of machine vision systems.



Refer to specific datasheets available at [www.opto-engineering.com](http://www.opto-engineering.com)  
for product compliancy with regulations, certifications and safety labels.



# Macro lenses



# MC series

Zero distortion macro lenses



## KEY ADVANTAGES

### Zero distortion

MC series are suitable for any measurement application where telecentricity is not required.

### High resolution

MC series has been specifically designed to work in macro configuration.

### Compactness

Small outer diameter (15 mm), fitting applications with limited space for optical components.

**MC series macro lenses** are designed to capture images of small objects when both very good resolution and nearly zero distortion are needed. Small object fields of view are often observed by means of long focal length lenses equipped with an additional spacer, used to adjust the working distance.

Unfortunately, this approach leads to several problems like high image distortion, resolution loss (especially at the corners), poor depth of field and chromatic effects, thus making this method not suitable for good imaging neither compatible with accurate measurement requirements.

All of these problems can be overcome by using MC series, specifically designed for macro imaging. MC series lenses are compact and cost-effective optics providing very high image resolution. A very low optical distortion makes these lenses perfectly suitable for precise dimensional measurement applications.

## Application examples







Part number	Mag. (x)	Image circle Ø (mm)	Detector type					Optical specifications					Mechanical specifications				
			1/3"	1/2.5"	1/2"	1/1.8"	2/3" - 5 Mpx	WD	Distortion	F/#	(wF/#)	Field depth	Mount	Length	Height	Diam.	
			w x h	w x h	w x h	w x h	w x h	(mm)	(%)			(mm)		(mm)	(mm)	(mm)	
			Object field of view (mm x mm)														
MC300X	3.00	11.0	1.60 x 1.20	1.90 x 1.43	2.13 x 1.60	2.38 x 1.79	2.82 x 2.36	29	< 0.01	5.0	(20)	0.15	C	106.5	30.0	15	
MC200X	2.00	11.0	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.56 x 2.68	4.22 x 3.53	33	< 0.01	5.3	(16)	0.25	C	78.1	30.0	15	
MC150X	1.50	11.0	3.20 x 2.40	3.80 x 2.85	4.27 x 3.20	4.75 x 3.58	5.63 x 4.71	38	< 0.01	5.2	(13)	0.35	C	63.9	30.0	15	
MC100X	1.00	11.0	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.37	8.45 x 7.07	47	< 0.01	5.0	(10)	0.6	C	49.9	30.0	15	
MC075X	0.75	11.0	6.40 x 4.80	7.60 x 5.70	8.53 x 6.40	9.50 x 7.16	11.3 x 9.42	58	< 0.02	5.1	(9)	1.1	C	42.8	30.0	15	
MC050X	0.50	11.0	9.60 x 7.20	11.4 x 8.55	12.8 x 9.60	14.3 x 10.7	16.9 x 14.1	75	< 0.02	5.3	(8)	2.1	C	35.7	30.0	15	
MC033X	0.33	11.0	14.4 x 10.8	17.1 x 12.8	19.2 x 14.4	21.4 x 16.1	25.4 x 21.2	102	< 0.05	5.3	(7)	3.7	C	31.0	30.0	15	

1 F/# = F-number, wF/# = Working F-number, the real F-number of a lens when used as a macro.

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

# MC3-03X macro

Zero distortion multi-configuration macro lens



## KEY ADVANTAGES

### Wide range of magnifications

MC3-03X is suitable for the inspection of many different object sizes with different detector options.

### Nearly zero distortion

Less than 0.05% distortion, at any magnification, makes this lens a perfect choice for measurement applications.

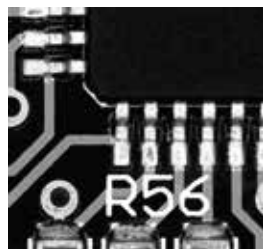
### Perfect optical parameters mix

Changing the magnification also changes the lens working F-number in such a way that resolution and distortion remain properly combined.

**MC3-03X is a multi-configuration macro lens** suitable for the inspection of objects whose size varies from a few millimeters to some centimeters. Magnification and focus can be tuned by adjusting a lockable rotating knob. The lens magnification range can be selected by means of a set of extension tubes, included in the product package; this feature makes this component ideal for prototyping purposes and for

machine vision applications requiring flexibility. Since the working F-number increases with magnification, the optimum combination of field depth, image resolution and brightness is maintained in any lens configuration. Moreover, the optical distortion approaches zero at any magnification, making this lens perfectly suitable for measurement applications.

## Application examples





### MC3-03X macro FOV and WD selection chart

Number of spacers	Mag. (x)	Image circle Ø (mm)	WD (mm)	F/#	(wF/#)	Field depth (mm)	Detector type					Dimensions		
							1/3" w x h (mm x mm)	1/2.5" w x h (mm x mm)	1/2" w x h (mm x mm)	1/1.8" w x h (mm x mm)	2/3" - 5 Mpx w x h (mm x mm)	Mount	Length (mm)	Diam. (mm)
							Object field of view (mm x mm)							
0	0.1	11.0	275	5.5	(6)	19	48.0 x 36.0	57.0 x 42.8	64.0 x 48.0	71.3 x 53.7	84.5 x 70.7	C	50.5	28
	0.2	11.0	136	5.0	(6)	5	24.0 x 18.0	28.5 x 21.4	32.0 x 24.0	35.6 x 26.8	42.2 x 35.3			
	0.3	11.0	92	5.4	(7)	2.5	16.0 x 12.0	19.0 x 14.3	21.3 x 16.0	23.8 x 17.9	28.2 x 23.6			
	0.4	11.0	71	5.0	(7)	1.5	12.0 x 9.00	14.3 x 10.7	16.0 x 12.0	17.8 x 13.4	21.1 x 17.7			
	0.5	11.0	60	5.3	(8)	1.1	9.60 x 7.20	11.4 x 8.55	12.8 x 9.60	14.3 x 10.7	16.9 x 14.1			
	0.6	11.0	54	5.6	(9)	0.8	8.00 x 6.00	9.50 x 7.13	10.7 x 8.00	11.9 x 8.95	14.1 x 11.8			
	0.7	11.0	50	5.3	(9)	0.6	6.86 x 5.14	8.15 x 6.11	9.14 x 6.86	10.2 x 7.67	12.1 x 10.1			
	0.8	11.0	47	5.6	(10)	0.5	6.00 x 4.50	7.13 x 5.35	8.00 x 6.00	8.91 x 6.71	10.6 x 8.83			
	0.9	11.0	46	5.3	(10)	0.4	5.33 x 4.00	6.34 x 4.75	7.11 x 5.33	7.92 x 5.96	9.38 x 7.85			
	1.0	11.0	46	5.5	(11)	0.4	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.37	8.45 x 7.07			
1	0.7	11.0	31	5.3	(9)	0.6	6.86 x 5.14	8.15 x 6.11	9.14 x 6.86	10.2 x 7.67	12.1 x 10.1	C	69.0	28
	0.8	11.0	29	5.6	(10)	0.5	6.00 x 4.50	7.13 x 5.35	8.00 x 6.00	8.91 x 6.71	10.6 x 8.83			
	0.9	11.0	28	5.3	(10)	0.4	5.33 x 4.00	6.34 x 4.75	7.11 x 5.33	7.92 x 5.96	9.38 x 7.85			
	1.0	11.0	27	5.5	(11)	0.4	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.37	8.45 x 7.07			
	1.1	11.0	28	5.2	(11)	0.3	4.36 x 3.27	5.18 x 3.89	5.82 x 4.36	6.48 x 4.88	7.68 x 6.42			
	1.2	11.0	28	5.5	(12)	0.3	4.00 x 3.00	4.75 x 3.56	5.33 x 4.00	5.94 x 4.47	7.04 x 5.89			
	1.3	11.0	29	5.2	(12)	0.24	3.69 x 2.77	4.39 x 3.29	4.92 x 3.69	5.48 x 4.13	6.50 x 5.44			
	1.4	11.0	31	5.4	(13)	0.2	3.43 x 2.57	4.07 x 3.05	4.57 x 3.43	5.09 x 3.83	6.03 x 5.05			
2	1.5	11.0	32	5.2	(13)	0.19	3.20 x 2.40	3.80 x 2.85	4.27 x 3.20	4.75 x 3.58	5.63 x 4.71	C	87.5	28
	1.6	11.0	34	5.4	(14)	0.2	3.00 x 2.25	3.56 x 2.67	4.00 x 3.00	4.46 x 3.36	5.28 x 4.42			
	1.4	11.0	12	5.4	(13)	0.21	3.43 x 2.57	4.07 x 3.05	4.57 x 3.43	5.09 x 3.83	6.03 x 5.05			
	1.5	11.0	14	5.2	(13)	0.19	3.20 x 2.40	3.80 x 2.85	4.27 x 3.20	4.75 x 3.58	5.63 x 4.71			
	1.6	11.0	15	5.4	(14)	0.18	3.00 x 2.25	3.56 x 2.67	4.00 x 3.00	4.46 x 3.36	5.28 x 4.42			
	1.7	11.0	17	5.2	(14)	0.16	2.82 x 2.12	3.35 x 2.52	3.76 x 2.82	4.19 x 3.16	4.97 x 4.16			
	1.8	11.0	19	5.4	(15)	0.15	2.67 x 2.00	3.17 x 2.38	3.56 x 2.67	3.96 x 2.98	4.69 x 3.93			
	1.9	11.0	21	5.2	(15)	0.14	2.53 x 1.89	3.00 x 2.25	3.37 x 2.53	3.75 x 2.83	4.45 x 3.72			
	2.0	11.0	23	5.3	(16)	0.13	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.56 x 2.68	4.22 x 3.53			
	2.1	11.0	25	5.2	(16)	0.12	2.29 x 1.71	2.72 x 2.04	3.05 x 2.29	3.39 x 2.56	4.02 x 3.36			
3	2.2	11.0	27	5.3	(17)	0.12	2.18 x 1.64	2.59 x 1.94	2.91 x 2.18	3.24 x 2.44	3.84 x 3.21	C	106.0	28
	2.3	11.0	30	5.5	(18)	0.11	2.09 x 1.57	2.48 x 1.86	2.78 x 2.09	3.10 x 2.33	3.67 x 3.07			
	2.1	11.0	7	5.2	(16)	0.12	2.29 x 1.71	2.72 x 2.04	3.05 x 2.29	3.39 x 2.56	4.02 x 3.36			
	2.2	11.0	9	5.3	(17)	0.12	2.18 x 1.64	2.59 x 1.94	2.91 x 2.18	3.24 x 2.44	3.84 x 3.21			
	2.3	11.0	11	5.5	(18)	0.11	2.09 x 1.57	2.48 x 1.86	2.78 x 2.09	3.10 x 2.33	3.67 x 3.07			
	2.4	11.0	14	5.3	(18)	0.10	2.00 x 1.50	2.38 x 1.78	2.67 x 2.00	2.97 x 2.24	3.52 x 2.94			
	2.5	11.0	16	5.4	(19)	0.10	1.92 x 1.44	2.28 x 1.71	2.56 x 1.92	2.85 x 2.15	3.38 x 2.83			
	2.6	11.0	18	5.3	(19)	0.09	1.85 x 1.38	2.19 x 1.64	2.46 x 1.85	2.74 x 2.06	3.25 x 2.72			
	2.7	11.0	21	5.4	(20)	0.09	1.78 x 1.33	2.11 x 1.58	2.37 x 1.78	2.64 x 1.99	3.13 x 2.62			
	2.8	11.0	23	5.3	(20)	0.09	1.71 x 1.29	2.04 x 1.53	2.29 x 1.71	2.55 x 1.92	3.02 x 2.52			
2.9	11.0	26	5.4	(21)	0.08	1.66 x 1.24	1.97 x 1.47	2.21 x 1.66	2.46 x 1.85	2.91 x 2.44				
3.0	11.0	28	5.3	(21)	0.08	1.60 x 1.20	1.90 x 1.43	2.13 x 1.60	2.38 x 1.79	2.82 x 2.36				

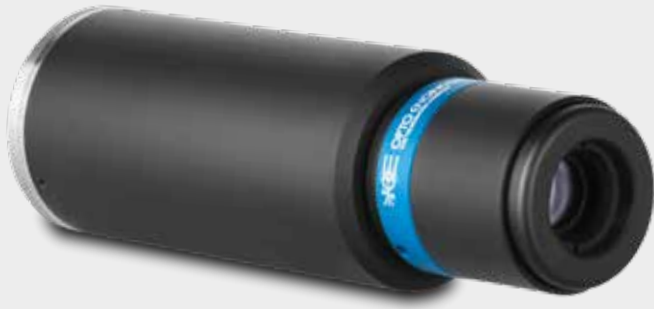
1 F/# = F-number, wF/# = Working F-number, the real F-number of a lens when used as a macro.

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

# MC4K series

Macro lenses for 4 k pixel linescan cameras

**NEW**



## KEY ADVANTAGES

### Macro design

Achieve unmatched resolution in critical applications: these objectives consistently deliver superior image quality than standard fixed focal length lenses used with extension tubes.

### Exceptional low distortion

Perform measurement tasks with a high degree of accuracy and reliability.

### Optimized aperture

For each magnification, the F/# is optimized to ensure the best field depth and image resolution.

### Easy front filter insertion

Thanks to the front M30.5x0.5 thread.

**MC4K series** is a collection of macro lenses fitting both 4K linescan cameras and matrix detector cameras over 4/3".

These lenses are specifically designed to work as macros, as opposed to infinite conjugate lenses with added spacers: a common alternative but unable to deliver the same optical performances.

MC4K lenses feature a fixed aperture, selected to ensure optimal field depth, image resolution and brightness for each magnification range, while meeting the typical needs of machine vision applications. The absence of an iris adjustment mechanism leads to a simpler and streamlined build, granting extra durability and precision.

Machine integration is made easy thanks to the precise focusing mechanism and the possibility to choose from an F or M42x1 mount (-N). MC4K series additionally features a front M30.5x0.5 thread for the insertion of an optional filter as well as easy phase adjustment.

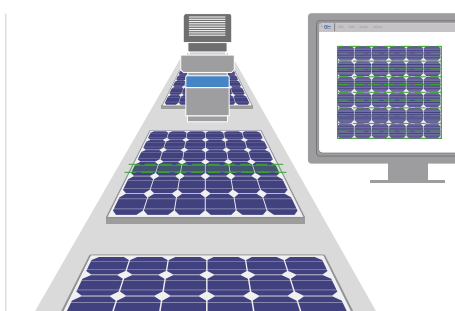


Mount F



Mount N = M42x1

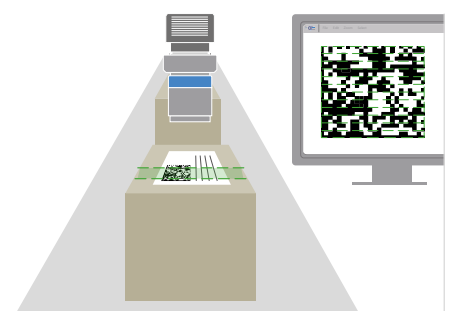
## Application examples



Solar cell inspection



Print and web inspection

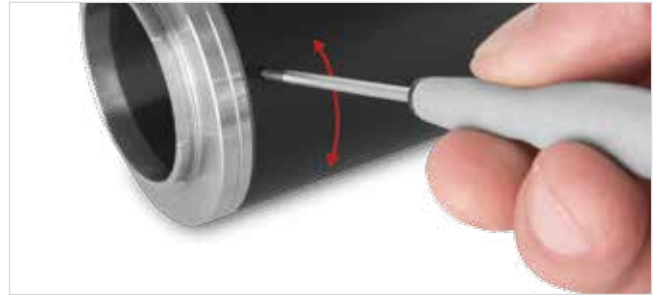


Identification: data-matrix and barcode reading



### Phase adjustment

Adjusting the phase of the camera mounted on MC4K macro lenses is easy: simply loosen the three set screws and rotate the camera mount until you achieve the desired angular alignment.



Part number	Focusing	Mag.	Detector type					Optical specifications							Dimensions				
			Line		Line		WD	F/#	(wF/#)	Distortion	Field	CTF	Image	Object	Length		Diam.		
			KAI-04050	2 kpx	KAI4022/4021	KAI-08050									4 kpx	(mm)	(%)	(mm)	(%)
			12.80 x 9.60	2 k x 10 µm	15.20 x 15.20	18.10 x 13.60	4 k x 7 µm												
		(x)	(mm x mm)	(mm)	(mm)	(mm)													
		<b>1</b>		<b>Object field of view (mm x mm)</b>						<b>2</b>	<b>3</b>	<b>4</b>			<b>5</b>	<b>F</b>	<b>N</b>	<b>F</b>	<b>N</b>
MC4K 025X-x	near	0.295	43.4 x 32.5	69.4	51.5 x 51.5	61.4 x 46.1	97.2	298.5											
	nominal	<b>0.250</b>	<b>51.2 x 38.4</b>	<b>81.9</b>	<b>60.8 x 60.8</b>	<b>72.4 x 54.4</b>	<b>114.7</b>	<b>346.1</b>	6.4	(8)	< 0.08 (0.1)	6.8	>60	0.063	0.018	80.0	115.9	64.0	52.0
MC4K 050X-x	far	0.205	62.4 x 46.8	99.9	74.1 x 74.1	88.3 x 66.3	139.9	414.3											
	near	0.545	23.5 x 17.6	37.6	27.9 x 27.9	33.2 x 25.0	52.6	177.0											
MC4K 050X-x	nominal	<b>0.500</b>	<b>25.6 x 19.2</b>	<b>41.0</b>	<b>30.4 x 30.4</b>	<b>36.2 x 27.2</b>	<b>57.3</b>	<b>189.9</b>	6.7	(10)	< 0.04 (0.08)	2.5	> 50	0.050	0.027	99.5	135.4	64.0	52.0
	far	0.455	28.1 x 21.1	45.0	33.4 x 33.4	39.8 x 29.9	63.0	205.2											
MC4K 075X-x	near	0.795	16.1 x 12.1	25.8	19.1 x 19.1	22.8 x 17.1	36.1	131.4											
	nominal	<b>0.750</b>	<b>17.1 x 12.8</b>	<b>27.3</b>	<b>20.3 x 20.3</b>	<b>24.1 x 18.1</b>	<b>38.2</b>	<b>137.3</b>	6.3	(11)	< 0.04 (0.08)	1.3	> 50	0.045	0.036	113.6	149.5	64.0	52.0
MC4K 100X-x	far	0.704	18.2 x 13.6	29.1	21.6 x 21.6	25.7 x 19.3	40.7	143.9											
	near	1.045	12.2 x 9.19	19.6	14.5 x 14.5	17.3 x 13.0	27.4	108.2											
MC4K 100X-x	nominal	<b>1.000</b>	<b>12.8 x 9.60</b>	<b>20.5</b>	<b>15.2 x 15.2</b>	<b>18.1 x 13.6</b>	<b>28.7</b>	<b>111.6</b>	6.5	(13)	< 0.01 (0.03)	0.9	> 50	0.038	0.040	132.9	168.8	64.0	52.0
	far	0.954	13.4 x 10.1	21.5	15.9 x 15.9	19.0 x 14.3	30.1	115.2											
MC4K 125X-x	near	1.295	9.88 x 7.41	15.8	11.7 x 11.7	14.0 x 10.5	22.1	94.0											
	nominal	<b>1.250</b>	<b>10.2 x 7.68</b>	<b>16.4</b>	<b>12.2 x 12.2</b>	<b>14.5 x 10.9</b>	<b>22.9</b>	<b>96.1</b>	6.7	(15)	< 0.01 (0.03)	0.7	> 40	0.033	0.043	152.2	188.1	64.0	52.0
MC4K 150X-x	far	1.204	10.6 x 7.97	17.0	12.6 x 12.6	15.0 x 11.3	23.8	98.5											
	near	1.543	8.30 x 6.22	13.3	9.85 x 9.85	11.7 x 8.81	18.6	89.9											
MC4K 150X-x	nominal	<b>1.500</b>	<b>8.53 x 6.40</b>	<b>13.7</b>	<b>10.1 x 10.1</b>	<b>12.1 x 9.07</b>	<b>19.1</b>	<b>91.4</b>	6.8	(17)	< 0.01 (0.03)	0.5	> 35	0.029	0.045	178.6	214.5	64.0	52.0
	far	1.455	8.80 x 6.60	14.1	10.4 x 10.4	12.4 x 9.35	19.7	93.0											
MC4K 175X-x	near	1.793	7.14 x 5.35	11.4	8.48 x 8.48	10.1 x 7.59	16.0	82.7											
	nominal	<b>1.750</b>	<b>7.31 x 5.49</b>	<b>11.7</b>	<b>8.69 x 8.69</b>	<b>10.3 x 7.77</b>	<b>16.4</b>	<b>83.8</b>	6.5	(18)	< 0.01 (0.03)	0.4	> 35	0.028	0.049	198.5	234.4	64.0	52.0
MC4K 200X-x	far	1.705	7.51 x 5.63	12.0	8.91 x 8.91	10.6 x 7.98	16.8	85.0											
	near	2.042	6.27 x 4.70	10.0	7.44 x 7.44	8.86 x 6.66	14.0	77.3											
MC4K 200X-x	nominal	<b>2.000</b>	<b>6.40 x 4.80</b>	<b>10.2</b>	<b>7.60 x 7.60</b>	<b>9.05 x 6.80</b>	<b>14.3</b>	<b>78.1</b>	6.7	(20)	< 0.01 (0.03)	0.4	> 30	0.025	0.050	218.4	254.4	64.0	52.0
	far	1.955	6.55 x 4.91	10.5	7.77 x 7.77	9.26 x 6.96	14.7	79.0											

- Maximum and minimum magnification changes when focusing.
- F/# = F-number, wF/# = Working F-number, the real F-number of a lens when used as a macro.
- Percent deviation of the real image compared to an ideal, undistorted image: typical (average production) values and maximum (guaranteed) values are listed.
- At the borders of the field depth the image can be still used for measurement but to get a perfectly sharp image only half of the nominal field depth should be taken into account.
- Measured from the front end of the mechanics to the camera flange; take into account a +/- 2.5 mm tolerance due to the focussing mechanism.

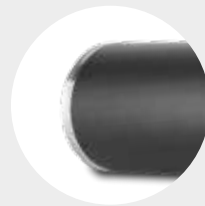
### Ordering information

It's easy to select the right lens for your application: our part numbers are coded as **MC4K yyyX-x** where **yyy** refers to the magnification and **-x** refers to the mount option:

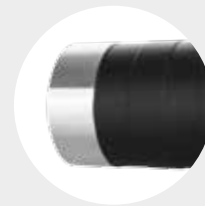
- **F** for F-mount
  - **N** for M42x1 mount (flange distance FD 10.56 mm).
- E.g. MC4K100X-N for a MC4K100X with M42x1 mount.

# MC12K series

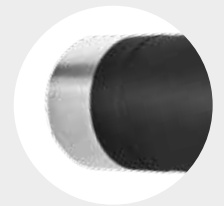
Macro lenses for 12 k and 16 k pixel linescan cameras



Mount F



Mount I = M58x0.75



Mount R = M72x0.75

**MC12K series** are macro lenses specifically optimized to work with high resolution line scan cameras with sensor size up to 62 mm. Infinite conjugate lenses, like photographic equipment optics, will offer poor performances when used to observe objects from up close: MC12K series are macro by design, enabling unmatched and uniform optical performances at short working distances.

MC12K series are the ideal choice for industrial applications where maximum image resolution is required: solar cells and printed sheets inspection, web inspection or high speed product sorting are just a few examples.

In addition to the standard M72x0.75 mount, MC12K lenses can be easily equipped with any camera mount at no additional cost ensuring wide compatibility with most common linescan cameras.

## KEY ADVANTAGES

### Macro design

Achieve unmatched resolution in critical applications.

### Exceptional low distortion

Perform measurement tasks with a high degree of accuracy and reliability.

### Optimized for high resolution linescan cameras

MC12K feature a large image circle ensuring wide compatibility with line scan sensors (up to 62.4 mm).

### Color correction

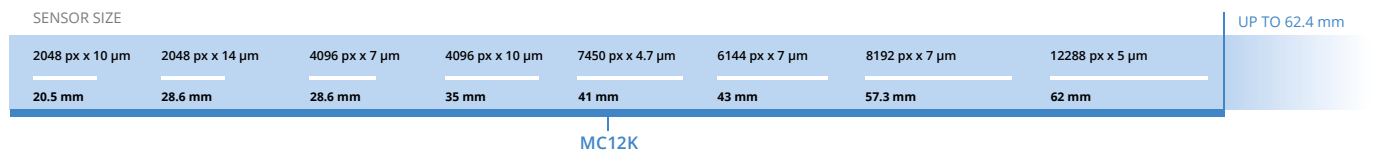
MC12K can distinguish the finest tonal gradations and are the ideal solution for demanding applications where color consistency is required.

### Industrial design for factory automation

MC12K feature precise manual focusing mechanism to achieve the best possible image sharpness.

## Wide image circle

MC12K is optimized to cover the line scan sensor sizes up to 62.4 mm.



## Application examples





## Tilting lens and projectors for accurate 3D reconstruction.

Opto Engineering designs **3D lenses and projectors** equipped with a **high-precision tilting mechanism** that allows the Scheimpflug condition to be met and to image the whole field of view in perfect focus. The Scheimpflug criterion describes how an object plane that is not parallel to the image plane can be imaged completely in focus. Tilting the Scheimpflug adaptor allows us to see the field of view in focus and also allows for a precise 3D measurement to be made.

A variety of 3D machine vision applications require that structured light be directed onto a sample at a considerable angle from a vertical position. However, when light is projected onto inclined surfaces, the focus is maintained only within a small area close to the centre of the field of view. The rest of the image will show relevant defocusing thus making the 3D measurement inaccurate.

3D pattern projectors have been specifically designed by Opto Engineering for 3D profiling and for the measurement of objects with complex structures or inclined planes. They are successfully used in a variety of applications like 3D profiling for quality control, food and packaging inspection, reverse engineering and dimensional measurement of electronic components.







3D optics

# MCSM1-01X

Macro lens with Scheimpflug adjustment



## KEY ADVANTAGES

### Precision Scheimpflug mount

Image focus is maintained across any tilted plane.

### Compatible with any C-mount camera

The back focal length meets the C-mount standard.

### Application flexibility

Supports a wide range of magnification factors and viewing angles.

**MCSM1-01X** is a macro lens expressly designed for 3D measurement and imaging applications where the object plane is not perpendicular to the optical axis. A precise built-in adjustment mechanism allows to accurately meet the Scheimpflug condition and to image tilted planes in perfect focus. This lens offers a wide range of magnifications and view angles. It can be interface with any

structured light source to build up extremely accurate 3D imaging systems. Image sharpness is maintained even when the lens is tilted by a wide angle, since the Scheimpflug adjustment tilts around the horizontal axis of the detector plane. The tiltable mount is compatible with any C-mount camera.

## Examples of 3D imaging configuration



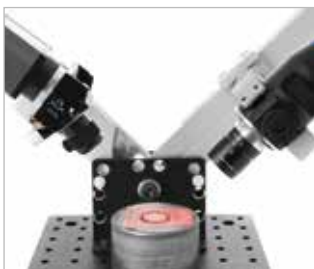
MCSM1-01X imaging a sample from an angled point of view.



Without tilt adjustment, the object is not homogeneously focused.



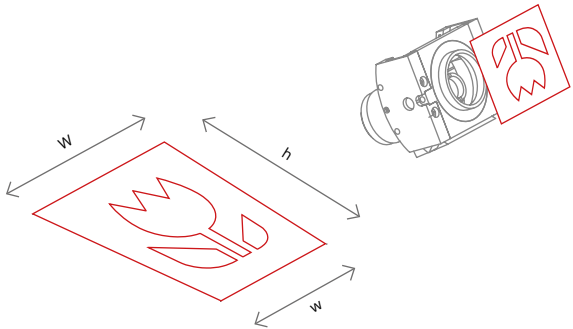
At the Scheimpflug angle, the image becomes sharp.



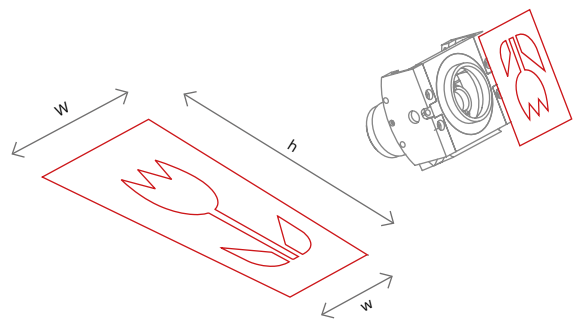
MCSM1-01X combined with a Scheimpflug projector at 90°.



MCSM1-01X working at 45° with a pattern projector for 3D shaping.



Field of view with detector long side set **horizontal**.



Field of view with detector long side set **vertical**.

### FOV and WD selection chart

Mag.	F/#	(wF/#)	Object tilt (deg)	Mount tilt (deg)	WD (mm)	Long detector side horizontal			Long detector side vertical		
						1/3" w x h	1/2" w x h	2/3" w x h	1/3" w x h	1/2" w x h	2/3" w x h
(x)						(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)
<b>1</b>						<b>Field of view - w (W) x h - (mm x mm)</b>					
1	6.3	12.5	0.0	0.0	46.0	4.80 (4.80) x 3.60	6.40 (6.40) x 4.80	8.80 (8.80) x 6.60	3.60 (3.60) x 4.80	4.80 (4.80) x 6.40	6.60 (6.60) x 8.80
			5.0	5.0	46.0	4.75 (4.85) x 3.61	6.33 (6.47) x 4.81	8.71 (8.89) x 6.61	3.55 (3.65) x 4.81	4.73 (4.87) x 6.41	6.51 (6.69) x 8.81
			10.0	10.0	46.0	4.70 (4.90) x 3.60	6.27 (6.53) x 4.80	8.62 (8.98) x 6.60	3.51 (3.70) x 4.81	4.68 (4.93) x 6.41	6.43 (6.78) x 8.81
			15.0	15.0	46.0	4.64 (4.95) x 3.61	6.18 (6.60) x 4.81	8.50 (9.08) x 6.61	3.46 (3.75) x 4.81	4.61 (5.00) x 6.41	6.34 (6.88) x 8.81
0.75	6.2	10.9	0.0	0.0	47.8	6.43 (6.43) x 4.82	8.57 (8.57) x 6.42	11.8 (11.8) x 8.83	4.82 (4.82) x 6.43	6.42 (6.42) x 8.57	8.83 (8.83) x 11.8
			7.5	5.7	47.8	6.33 (6.52) x 4.84	8.44 (8.70) x 6.45	11.6 (12.0) x 8.87	4.72 (4.92) x 6.45	6.29 (6.56) x 8.60	8.65 (9.02) x 11.8
			15.0	11.4	47.8	6.23 (6.63) x 4.89	8.31 (8.84) x 6.52	11.4 (12.2) x 8.97	4.63 (5.02) x 6.53	6.17 (6.70) x 8.71	8.48 (9.21) x 12.0
			20.0	15.3	47.8	6.17 (6.70) x 4.95	8.23 (8.93) x 6.60	11.3 (12.3) x 9.08	4.57 (1.83) x 6.61	6.09 (2.44) x 8.81	8.37 (3.35) x 12.1
0.5	6.3	9.4	0.0	0.0	59.6	9.63 (9.63) x 7.23	12.8 (12.8) x 9.64	17.7 (17.7) x 13.3	7.23 (7.23) x 9.63	9.64 (9.64) x 12.8	13.3 (13.3) x 17.7
			10.0	5.0	59.6	9.44 (9.83) x 7.31	12.6 (13.1) x 9.75	17.3 (18.0) x 13.4	7.03 (7.43) x 9.74	9.37 (9.91) x 13.0	12.9 (13.6) x 17.9
			20.0	10.4	59.6	9.25 (10.1) x 7.58	12.3 (13.4) x 10.1	17.0 (18.4) x 13.9	6.84 (7.65) x 10.1	9.12 (10.2) x 13.5	12.6 (14.0) x 18.6
			30.0	16.1	59.6	9.04 (10.3) x 8.05	12.1 (13.7) x 10.7	16.6 (18.9) x 14.8	6.65 (7.91) x 10.8	8.87 (10.5) x 14.4	12.2 (14.5) x 19.7
0.33	6.2	8.3	0.0	0.0	83.8	14.6 (14.6) x 10.9	19.4 (19.4) x 14.6	26.7 (26.7) x 20.1	10.9 (10.9) x 14.5	14.6 (14.6) x 19.4	20.1 (20.1) x 26.6
			15.0	5.1	83.8	14.1 (14.9) x 11.3	18.9 (19.9) x 15.1	25.9 (27.4) x 20.7	10.5 (11.4) x 15.1	14.0 (15.2) x 20.1	19.3 (20.9) x 27.6
			30.0	10.8	83.8	13.7 (15.6) x 12.5	18.2 (20.8) x 16.6	25.1 (28.6) x 22.8	10.0 (12.0) x 16.7	13.4 (16.0) x 22.2	18.4 (22.0) x 30.6
			45.0	18.3	83.8	13.1 (16.4) x 14.9	17.5 (21.9) x 19.8	24.1 (30.1) x 27.3	9.52 (12.9) x 20.0	12.7 (17.1) x 26.7	17.5 (23.6) x 36.7
0.2	6.3	7.5	0.0	0.0	135.3	24.0 (24.0) x 18.0	32.0 (32.0) x 24.0	44.0 (44.0) x 33.0	18.0 (18.0) x 24.0	24.0 (24.0) x 32.0	33.0 (33.0) x 44.0
			15.0	3.1	135.3	23.3 (24.8) x 18.6	31.0 (33.0) x 24.8	42.7 (45.4) x 34.2	17.3 (18.8) x 24.9	23.0 (25.1) x 33.1	31.7 (34.5) x 45.6
			30.0	6.6	135.3	22.5 (25.7) x 20.7	30.0 (34.3) x 27.7	41.2 (47.2) x 38.0	16.5 (19.8) x 27.8	22.0 (26.4) x 37.0	30.3 (36.3) x 50.9
			45.0	11.4	135.3	21.5 (27.1) x 25.3	28.7 (36.2) x 33.7	39.5 (49.7) x 46.4	15.6 (21.3) x 34.1	20.8 (28.4) x 45.4	28.6 (39.0) x 62.5
0.1	6.3	6.9	0.0	0.0	271.0	47.6 (47.6) x 35.7	63.5 (63.5) x 47.6	87.3 (87.3) x 65.5	35.7 (35.7) x 47.7	47.6 (47.6) x 63.6	65.5 (65.5) x 87.4
			15.0	1.6	271.0	46.2 (49.2) x 37.0	61.6 (65.6) x 49.4	84.7 (90.2) x 67.9	34.3 (37.3) x 49.4	45.7 (49.7) x 65.9	62.9 (68.4) x 90.6
			30.0	3.4	271.0	44.6 (51.1) x 41.4	59.5 (68.1) x 55.2	81.8 (93.7) x 75.8	32.8 (39.3) x 55.4	43.7 (52.4) x 73.8	60.1 (72.0) x 101.5
			45.0	5.8	271.0	42.7 (53.9) x 51.0	56.9 (71.9) x 68.0	78.2 (98.9) x 93.4	30.9 (42.3) x 68.7	41.2 (56.4) x 91.6	56.7 (77.6) x 125.9

1 F/# = F-number, wF/# = Working F-number, the real F-number of a lens when used as a macro.

# TCSM series

3D bi-telecentric lenses with Scheimpflug adjustment



## KEY ADVANTAGES

### Unique Scheimpflug adjustment

No other lens can perform oblique measurements.

### The image is radially undistorted

Linear extension can be perfectly calibrated.

### Compatible with any C-mount camera

C-mount standard compliant.

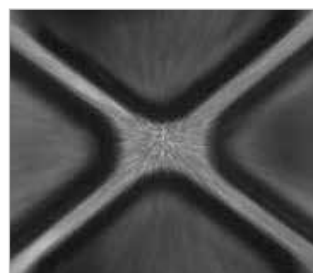
**TCSM series** is a unique family of bi-telecentric lenses for extremely accurate 3D dimensional measurement systems. All TCSM lenses are equipped with a high-precision Scheimpflug adjustment mechanism that fits any type of C-mount camera. Besides achieving very good focus at wide tilt angles, bi-telecentricity also yields incredibly low distortion. Images are linearly compressed only in one direction,

thus making 3D-reconstruction very easy and exceptionally accurate. The available magnifications range from 0.5x to 0.1x while the angle of view reaches 30°-45° to meet the measurement needs of triangulation-based techniques. The Scheimpflug mount tilts around the horizontal axis of the detector plane to ensure excellent pointing stability and ease of focus.

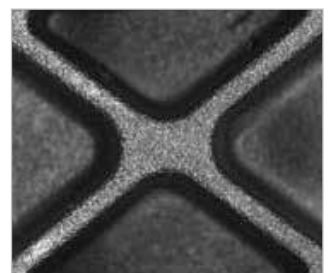
## Examples of high-end 3D measurements



TCSM imaging and measuring sloped objects.



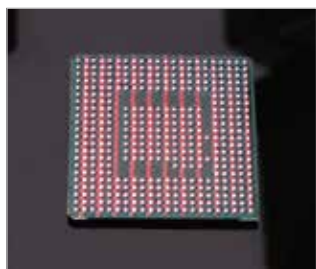
Without tilt adjustment, the object is not homogeneously focused.



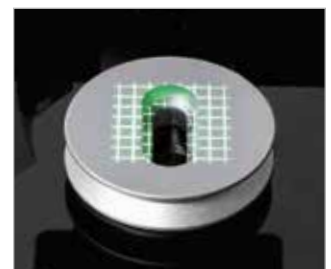
At the Scheimpflug angle, the image becomes sharp.

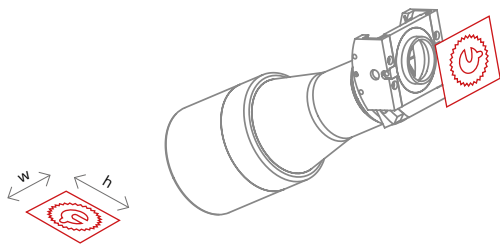


Scheimpflug telecentric optics for both projection and imaging at 90°.

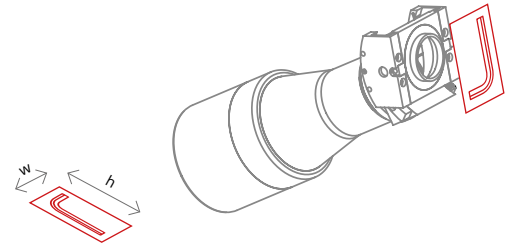


TCSM series lens for straight telecentric pattern projection.





Field of view with detector long side set **horizontal**.



Field of view with detector long side set **vertical**.

Part number	Object tilt (deg)	Mount tilt (deg)	WD (mm)	Horizontal mag (x)	Vertical mag (x)	Long detector side horizontal			Long detector side vertical		
						1/3"	1/2"	2/3"	1/3"	1/2"	2/3"
						w x h 4.80 x 3.60 (mm x mm)	w x h 6.40 x 4.80 (mm x mm)	w x h 8.80 x 6.60 (mm x mm)	w x h 3.60 x 4.80 (mm x mm)	w x h 4.80 x 6.40 (mm x mm)	w x h 6.60 x 8.80 (mm x mm)
			<b>1</b>			Field of view (mm x mm)			Field of view (mm x mm)		
TCSM 016	0.0	0.0	43.1	0.528	0.528	9.09 x 6.82	12.1 x 9.09	16.7 x 12.5	6.82 x 9.09	9.09 x 12.1	12.5 x 16.7
	10.0	5.3		0.528	0.522	9.09 x 6.89	12.1 x 9.19	16.7 x 12.6	6.82 x 9.20	9.09 x 12.3	12.5 x 16.9
	20.0	10.9		0.528	0.506	9.09 x 7.15	12.1 x 9.53	16.7 x 13.1	6.82 x 9.49	9.09 x 12.7	12.5 x 17.4
	30.0	17.0		0.528	0.478	9.09 x 7.54	12.1 x 10.1	16.7 x 13.8	6.82 x 10.0	9.09 x 13.4	12.5 x 18.4
TCSM 024	0.0	0.0	67.2	0.350	0.350	13.7 x 10.3	18.3 x 13.7	25.1 x 18.9	10.3 x 13.7	13.7 x 18.3	18.9 x 25.1
	15.0	5.4		0.350	0.338	13.7 x 10.6	18.3 x 14.2	25.1 x 19.5	10.3 x 14.2	13.7 x 18.9	18.9 x 26.0
	30.0	11.4		0.350	0.308	13.7 x 11.7	18.3 x 15.6	25.1 x 21.4	10.3 x 15.6	13.7 x 20.8	18.9 x 28.5
	45.0	19.3		0.350	0.262	13.7 x 13.7	18.3 x 18.3	25.1 x 25.2	10.3 x 18.3	13.7 x 24.4	18.9 x 33.6
TCSM 036	0.0	0.0	102.5	0.243	0.243	19.7 x 14.8	26.3 x 19.7	36.2 x 27.1	14.8 x 19.7	19.7 x 26.3	27.1 x 36.2
	15.0	3.7		0.243	0.235	19.7 x 15.3	26.3 x 20.4	36.2 x 28.1	14.8 x 20.4	19.7 x 27.2	27.1 x 37.4
	30.0	8.0		0.243	0.213	19.7 x 17.0	26.3 x 22.6	36.2 x 31.1	14.8 x 22.6	19.7 x 30.1	27.1 x 41.4
	45.0	13.6		0.243	0.177	19.7 x 20.4	26.3 x 27.2	36.2 x 37.4	14.8 x 27.1	19.7 x 36.2	27.1 x 49.7
TCSM 048	0.0	0.0	132.9	0.185	0.185	26.0 x 19.5	34.7 x 26.0	47.7 x 35.7	19.5 x 26.0	26.0 x 34.7	35.7 x 47.7
	15.0	2.8		0.185	0.181	26.0 x 20.1	34.7 x 26.8	47.7 x 36.9	19.5 x 26.5	26.0 x 35.3	35.7 x 48.6
	30.0	6.1		0.185	0.161	26.0 x 22.4	34.7 x 29.9	47.7 x 41.1	19.5 x 29.8	26.0 x 39.8	35.7 x 54.7
	45.0	10.5		0.185	0.133	26.0 x 27.1	34.7 x 36.2	47.7 x 49.8	19.5 x 36.1	26.0 x 48.2	35.7 x 66.2
TCSM 056	0.0	0.0	157.8	0.157	0.157	30.6 x 22.9	40.8 x 30.6	56.1 x 42.0	22.9 x 30.6	30.6 x 40.8	42.0 x 56.1
	15.0	2.4		0.157	0.152	30.6 x 23.7	40.8 x 31.7	56.1 x 43.5	22.9 x 31.6	30.6 x 42.2	42.0 x 58.0
	30.0	5.1		0.157	0.136	30.6 x 26.4	40.8 x 35.2	56.1 x 48.4	22.9 x 35.2	30.6 x 46.9	42.0 x 64.5
	45.0	8.8		0.157	0.112	30.6 x 32.1	40.8 x 42.8	56.1 x 58.8	22.9 x 42.8	30.6 x 57.0	42.0 x 78.4
TCSM 064	0.0	0.0	181.8	0.137	0.137	34.9 x 26.2	46.6 x 34.9	64.0 x 48.0	26.2 x 34.9	34.9 x 46.6	48.0 x 64.0
	15.0	2.1		0.137	0.133	34.9 x 27.1	46.6 x 36.2	64.0 x 49.8	26.2 x 36.1	34.9 x 48.2	48.0 x 66.3
	30.0	4.5		0.137	0.119	34.9 x 30.2	46.6 x 40.3	64.0 x 55.4	26.2 x 40.2	34.9 x 53.6	48.0 x 73.7
	45.0	7.8		0.137	0.098	34.9 x 36.8	46.6 x 49.0	64.0 x 67.4	26.2 x 49.0	34.9 x 65.3	48.0 x 89.8
TCSM 080	0.0	0.0	226.7	0.110	0.110	43.6 x 32.7	58.2 x 43.6	80.0 x 60.0	32.7 x 43.6	43.6 x 58.2	60.0 x 80.0
	15.0	1.7		0.110	0.107	43.6 x 33.8	58.2 x 45.0	80.0 x 61.9	32.7 x 45.0	43.6 x 60.0	60.0 x 82.5
	30.0	3.6		0.110	0.096	43.6 x 37.6	58.2 x 50.2	80.0 x 69.0	32.7 x 50.2	43.6 x 67.0	60.0 x 92.1
	45.0	6.3		0.110	0.078	43.6 x 45.9	58.2 x 61.2	80.0 x 84.2	32.7 x 61.2	43.6 x 81.7	60.0 x 112.3
TCSM 096	0.0	0.0	278.6	0.093	0.093	51.4 x 38.5	68.5 x 51.4	94.2 x 70.7	38.5 x 51.4	51.4 x 68.5	70.7 x 94.2
	15.0	1.4		0.093	0.090	51.4 x 39.9	68.5 x 53.2	94.2 x 73.1	38.5 x 53.2	51.4 x 70.9	70.7 x 97.5
	30.0	3.1		0.093	0.081	51.4 x 44.4	68.5 x 59.2	94.2 x 81.5	38.5 x 59.2	51.4 x 79.0	70.7 x 108.6
	45.0	5.3		0.093	0.066	51.4 x 54.4	68.5 x 72.5	94.2 x 99.7	38.5 x 72.4	51.4 x 96.6	70.7 x 132.8

**1** Working distance: distance between the front end of the mechanics and the object. Set this distance within +/- 3% of the nominal value for maximum resolution and minimum distortion.

# LTPRSMHP3W series

High-performance 3D LED pattern projectors

## PRODUCT UPDATE



### KEY ADVANTAGES

#### Scheimpflug tilt adjustment

For homogeneous focusing of the pattern features.

#### Tilt adjustment compatible with C-mount optics

Focus is maintained even when the pattern is tilted.

#### Light condenser focusing mechanism

For excellent optical coupling and light throughput.

#### Enhanced optical power

Due to the high numerical aperture condenser lens.

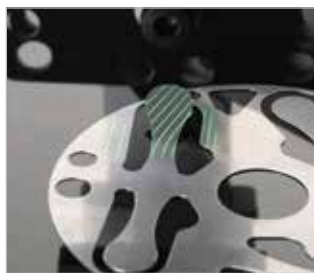
**LTPRSMHP3W series** are LED pattern projectors specifically designed for the most demanding 3D profiling and measurement applications. Triangulation techniques require that structured light is directed onto a sample at a considerable angle from vertical. Tilting the light source pattern becomes essential to ensure that the patterned light is properly and homogeneously focused across the

entire sample surface. LTPRSMHP3W pattern projectors integrate a precision tilting mechanism based on the Scheimpflug condition. This also ensures that the focus doesn't change when the pattern is tilted. Moreover, the internal focus mechanism offers the maximum optical throughput. The projected light path is effectively coupled to the pupil aperture of any C-mount lens.

### Examples of setup and applications



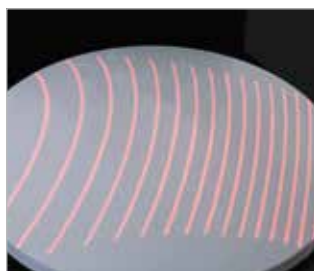
Configuration with zero distortion macro lenses.



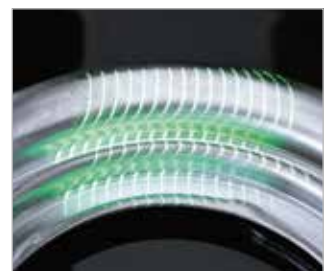
Configuration with bi-telecentric lenses.



LTPRSM pattern projector with a standard C-mount lens.

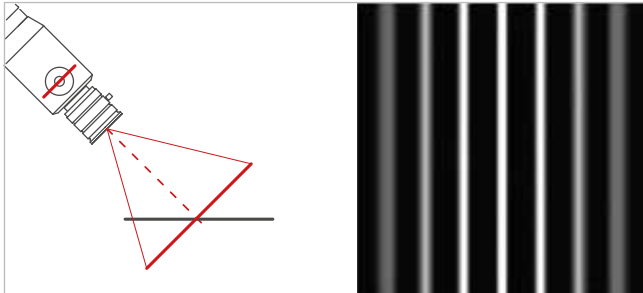


Scheimpflug telecentric optics for both projection and imaging at 90°.

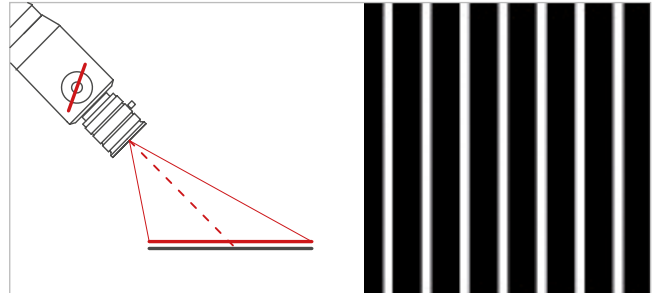


## NEW LIGHT SOURCE

- Higher efficiency
- Precise light intensity adjustment
- Easy LED source replacement



Without tilt adjustment the pattern features are only partly focused.



With the Scheimpflug adjustment focus is maintained across the entire plane.

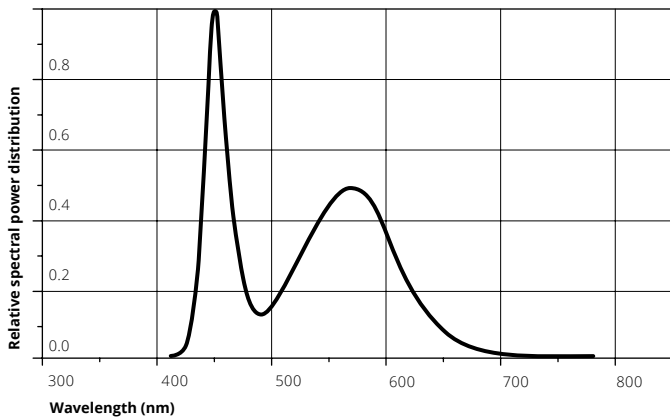


## Electrical features

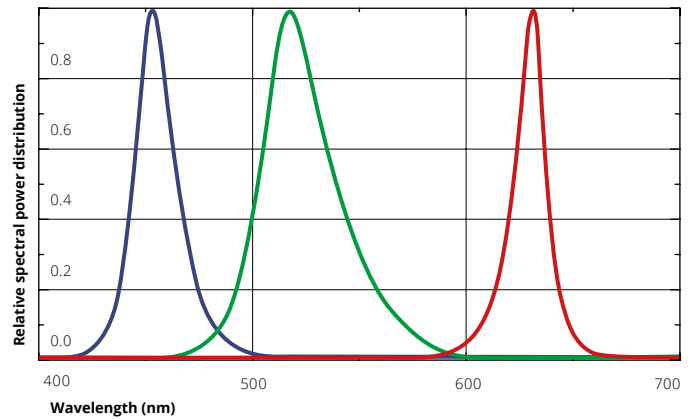
These LED devices integrate built-in switching electronics that control the current flow through the LED and which can be easily tuned by the user. This ensures both high light stability and a longer lifetime of the product.

The inner circuitry can be bypassed to directly drive the LED. Simply connect the black and blue wires to your power supply instead of the black and brown ones, ensuring that maximum rates are not exceeded.

## Typical emission spectrum of white LEDs



## Typical emission spectrum of R,G,B LEDs



Part number	Light Light color, wavelength peak	Device power ratings				LED power ratings		
		DC Voltage		Power consumption (W)	Max LED forward current (mA)	Forward voltage		Max pulse current (mA)
		Minimum (V)	Maximum (V)			Typical (V)	Maximum (V)	
LTPRSMHP 3W-R	red, 630 nm	12	24	< 4.5	720	2.4	3.00	2000
LTPRSMHP 3W-G	green, 520 nm	12	24	< 4.5	720	3.3	4.00	2000
LTPRSMHP 3W-B	blue, 460 nm	12	24	< 4.5	720	3.3	4.00	2000
LTPRSMHP 3W-W	white	12	24	< 4.5	720	2.78	n.a.	2000

1 Used in continuous (not pulsed) mode.

2 At max forward current. Tolerance is  $\pm 0.06V$  on forward voltage measurements.

3 At pulse width  $\leq 10$  ms, duty cycle  $\leq 10\%$  condition.

Built-in electronics board must be bypassed (see tech info online).

# LTPRSMHP3W series

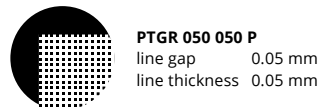
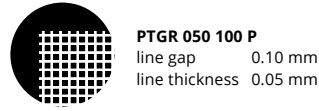
## Product insight



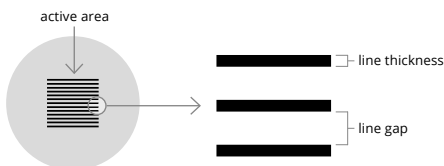
### Photolithography stripe patterns



### Photolithography grid patterns



### Pattern detail



The projection pattern placed inside the unit can be changed and integrated with ease: just remove the C-mount adaptor by loosening the set-screws and fix the pattern by screwing the retaining ring.

Different types of stripe and grid patterns are available; the chart shows the line thickness (0.05 mm) and the gap between neighboring lines for each pattern type.

When these features are projected, they become 1/M times larger, with "M" being the magnification of the projection lens. The number of lines mentioned after each part number indicates the number of features on the active area of the pattern.

### Pattern specifications

#### Photolithography patterns

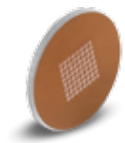
Substrate	Soda lime glass
Coating	Chrome
Geometrical accuracy	2 µm
Edge sharpness	1.4 µm

### RT SERIES

Full range of compatible optics available.  
Visit [www.opto-engineering.com/rt-series](http://www.opto-engineering.com/rt-series) to select the most appropriate C-mount fixed focal length optics.



## Accessories / Compatibility



Patterns



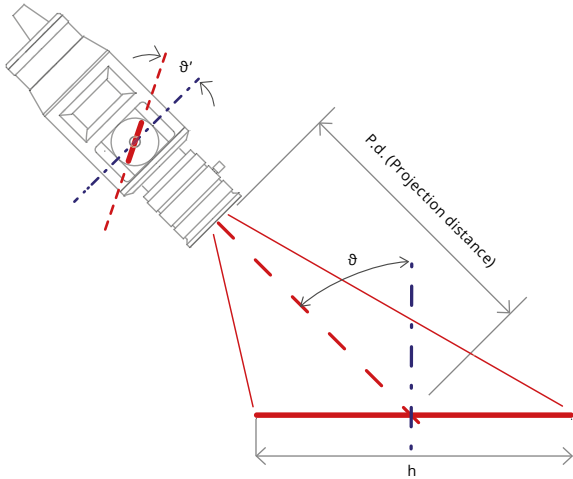
Bi-telecentric lenses



Macro lenses



Standard C-mount lenses

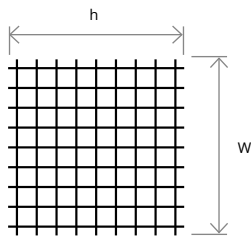


**LTPRSMHP3W series** units can be interfaced with any type of optics, but the best results are achieved with bi-telecentric lenses. The projection area is undistorted since tilting the pattern causes a linear extension along only one direction.

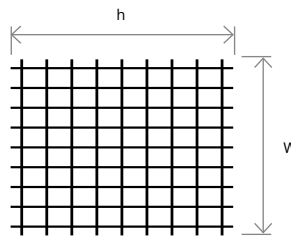
Excellent results can also be obtained with zero distortion macro lenses; here, the magnification changes along both axes, but image resolution and distortion still easily allows 3D reconstruction.

With non bi-telecentric lenses, a square pattern becomes a trapezoid in the projection plane, whose parallel sides are indicated as “w” and “W” in the drawings below.

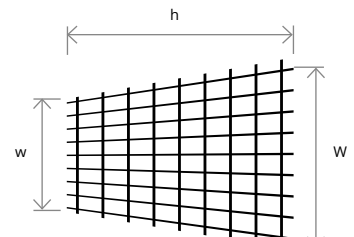
The projection area shown in the chart are also a good approximation for standard C-mount lenses used as macro lenses (eventually equipped with spacers).



Original pattern features



Projection area with a bi-telecentric lens



Projection area with a macro lens

### Projection area with bi-telecentric lenses (TC series)

Part number	Projection distance P.d. (mm)	$\theta = 0^\circ$		$\theta = 15^\circ$		$\theta = 30^\circ$		$\theta = 45^\circ$	
		Projection area W x h (mm x mm)	Pattern tilt $\theta'$ (deg)	Projection area W x h (mm x mm)	Pattern tilt $\theta'$ (deg)	Projection area W x h (mm x mm)	Pattern tilt $\theta'$ (deg)	Projection area W x h (mm x mm)	Pattern tilt $\theta'$ (deg)
TC 23 009	63.3	8.0 x 8.0	0	8.0 x 8.0	15.0	8.0 x 8.0	30.0	8.0 x 8.0	45.0
TC 23 016	45.3	15.2 x 15.2	0	15.2 x 15.4	8.1	15.2 x 16.8	17.0	15.2 x 20.0	27.8
TC 23 024	69.2	22.9 x 22.9	0	22.9 x 23.6	5.4	22.9 x 26.0	11.4	22.9 x 30.5	19.3
TC 23 036	103.5	32.9 x 32.9	0	32.9 x 34.0	3.7	32.9 x 37.7	8.0	32.9 x 45.3	13.6
TC 23 048	134.6	43.3 x 43.3	0	43.3 x 44.7	2.8	43.3 x 49.8	6.1	43.3 x 60.3	10.5
TC 23 056	159.3	51.0 x 51.0	0	51.0 x 52.8	2.4	51.0 x 58.6	5.1	51.0 x 71.3	8.8
TC 23 064	182.0	58.2 x 58.2	0	58.2 x 60.3	2.1	58.2 x 67.1	4.5	58.2 x 81.7	7.8
TC 23 080	227.0	72.7 x 72.7	0	72.7 x 73.8	1.7	72.7 x 83.6	3.6	72.7 x 102.0	6.3
TC 23 096	279.0	85.6 x 85.6	0	85.6 x 88.6	1.4	85.6 x 98.7	3.1	85.6 x 120.9	5.3

### Projection area with macro (MC3-03x and MC series) and standard lenses

Mag. (x)	Projection distance P.d. (mm)	$\theta = 0^\circ$			$\theta = 15^\circ$			$\theta = 30^\circ$			$\theta = 45^\circ$		
		w (mm)	(W) x h (mm x mm)	Pattern tilt $\theta'$ (deg)	w (mm)	(W) x h (mm x mm)	Pattern tilt $\theta'$ (deg)	w (mm)	(W) x h (mm x mm)	Pattern tilt $\theta'$ (deg)	w (mm)	(W) x h (mm x mm)	Pattern tilt $\theta'$ (deg)
1	46.0	8.0	(8.0) x 8.0	0	7.7	(8.3) x 8.0	15.0	7.5	(8.6) x 8.1	30.0	7.3	(8.9) x 8.1	45.0
0.75	48.0	10.7	(10.7) x 10.7	0	10.3	(11.1) x 10.9	11.4	10.0	(11.6) x 11.4	23.5	9.6	(12.1) x 12.3	37.0
0.5	60.0	16.1	(16.1) x 16.1	0	15.5	(16.7) x 16.5	7.6	14.9	(17.5) x 17.9	16.2	14.3	(18.4) x 20.7	26.7
0.33	92.0	24.3	(24.3) x 24.3	0	23.4	(25.3) x 25.1	5.1	22.5	(26.5) x 27.8	10.8	21.4	(28.1) x 33.3	18.3
0.2	136.0	40.1	(40.1) x 40.1	0	38.6	(41.6) x 42.1	3.1	37.0	(43.6) x 46.2	6.6	35.1	(46.6) x 56.8	11.4
0.1	275.0	79.5	(79.5) x 79.5	0	76.6	(82.6) x 82.4	1.6	73.5	(86.6) x 92.3	3.4	69.6	(92.6) x 114.2	5.8

# LTPRHP3W series

High-performance LED pattern projectors

## PRODUCT UPDATE



### KEY ADVANTAGES

#### Perfectly sharp edges

LTPR series ensures thinner lines, sharper edges and more homogeneous illumination than lasers.

With laser emitters the illumination decays both across the line cross section and along the line width.

Laser emitters lines are thicker and show blurred edges; diffraction and speckle effects are also present.

**LTPRHP3W series** are the most advanced and efficient devices for pattern projection and structured light applications, such as 3D reconstruction.

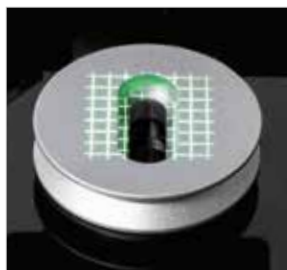
Unlike laser sources, which typically show poor line sharpness and power distribution inhomogeneity as well as scattering and diffraction effects, LTPR pattern projectors overcome all of these problems by integrating LED sources and precisely engraved masks. Any kind of pattern shape can be easily supplied, integrated and projected by these devices.

Different colors are available and the size of the projection area can be easily modified by interchanging the projection optics.

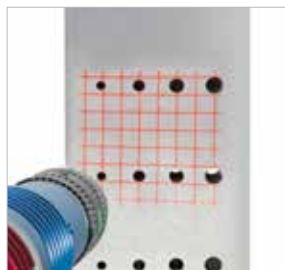
### NEW LIGHT SOURCE

- Higher efficiency
- Precise light intensity adjustment
- Easy LED source replacement

### Application examples



3D reconstruction



Mechanical alignment



Visualization & mapping



Telecentric pattern projection

## Every kind of shape can be projected

### Standard patterns



Stripe 0.5 mm line thickness



Edge

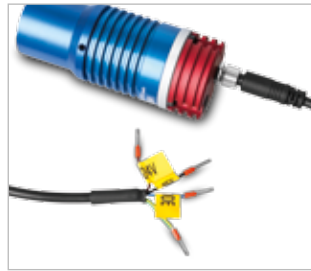
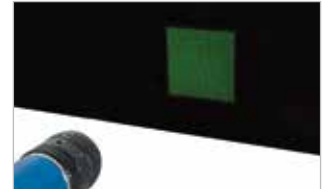


Grid 0.05 mm line thickness



Line 0.5 mm line thickness

### Custom patterns

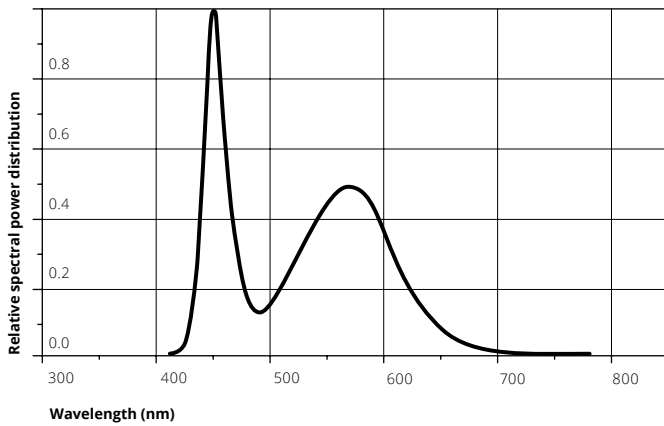


### Electrical features

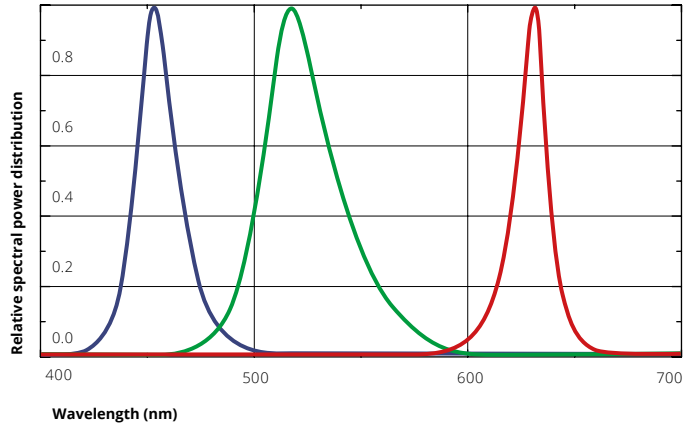
These LED devices integrate built-in switching electronics that control the current flow through the LED and which can be easily tuned by the user. This ensures both high light stability and a longer lifetime of the product.

The inner circuitry can be bypassed in order to directly drive the LED. Simply connect the black and blue wires to your power supply instead of the black and brown ones, ensuring that the maximum rates are not exceeded.

### Typical emission spectrum of white LEDs



### Typical emission spectrum of R,G,B LEDs



Part number	Light Light color, wavelength peak	Device power ratings				LED power ratings		
		DC Voltage		Power consumption	Max LED forward current	Forward voltage		Max pulse current
		Minimum (V)	Maximum (V)	(W)	(mA)	Typical (V)	Maximum (V)	(mA)
LTPRHP3W-R	red, 630 nm	12	24	< 4.5	720	2.4	3.00	2000
LTPRHP3W-G	green, 520 nm	12	24	< 4.5	720	3.3	4.00	2000
LTPRHP3W-B	blue, 460 nm	12	24	< 4.5	720	3.3	4.00	2000
LTPRHP3W-W	white	12	24	< 4.5	720	2.78	n.a.	2000

1 Used in continuous (not pulsed) mode.

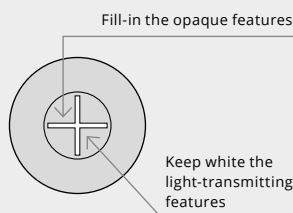
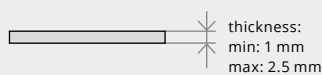
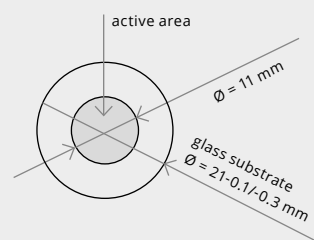
2 At max forward current. Tolerance is  $\pm 0.06V$  on forward voltage measurements.

3 At pulse width  $\leq 10$  ms, duty cycle  $\leq 10\%$  condition.

Built-in electronics board must be bypassed (see tech info online).

# LTPRHP3W series

## Product insight



### Custom-made pattern

Custom-made patterns can be supplied on request. A drawing with accurate geometrical information must be submitted (please refer to the instructions here below).

### Photolithography patterns

**PT 0000 0100 P**  
design: line pattern  
line thickness 0.05 mm

**PT 0000 0200 P**  
design: cross pattern  
line thickness 0.05 mm

**PT 0000 0300 P**  
design: stripe pattern  
line gap 0.95 mm  
line thickness 0.05 mm

**PT 0000 0400 P**  
design: grid pattern  
line gap 0.95 mm  
line thickness 0.05 mm

**PT 0000 0500 P**  
design: edge pattern  
line gap 0.10 mm  
line thickness 0.05 mm

### Laser engraved patterns

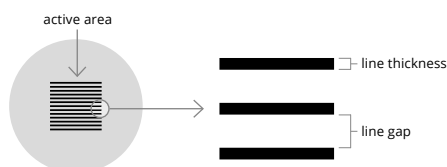
**PT 0000 0100 L**  
design: line pattern  
line thickness 0.5 mm

**PT 0000 0200 L**  
design: cross pattern  
line thickness 0.5 mm

**PT 0000 0300 L**  
design: stripe pattern  
line gap 0.5 mm  
line thickness 0.5 mm

**PT 0000 0400 L**  
design: grid pattern  
line gap 0.8 mm  
line thickness 0.2 mm

**PT 0000 0500 L**  
design: edge pattern  
line gap 0.10 mm  
line thickness 0.5 mm



### Pattern selection

The projection pattern can be easily integrated into the LTPR projection unit by unscrewing the retaining ring that holds the pattern itself.

This simple procedure makes it easy to interchange different patterns on the same projection unit. The pattern outer diameter is 21 mm, while the active projection area is a circle of Ø 11 mm: all the significant features of the pattern are drawn inside this circle.

The projection area will have the same aspect ratio as the pattern. The projection accuracy depends both on the pattern manufacturing accuracy and lens distortion. The edge sharpness of the projected pattern depends on both the lens resolution and the engraving technique: laser-engraved patterns (part numbers ending in "L") or photolithography-engraved patterns (part numbers ending in "P") can be chosen depending on the type of application.

#### Pattern specifications

##### Photolithography patterns

Substrate	Soda lime glass
Coating	Chrome
Geometrical accuracy	2 µm
Edge sharpness	1.4 µm

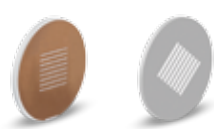
##### Laser engraved patterns

Substrate	Borofloat glass
Coating	Dichroic mirror
Geometrical accuracy	50 µm
Edge sharpness	50 µm

#### RT SERIES

Full range of compatible optics available. Visit [www.opto-engineering.com/rt-series](http://www.opto-engineering.com/rt-series) to select the most appropriate C-mount fixed focal length optics.

## Accessories / Compatibility



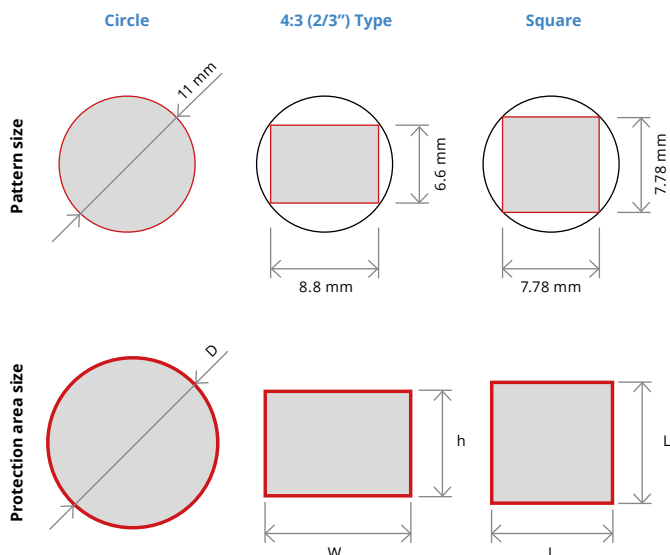
Patterns



Bi-telecentric lenses



Standard C-mount lenses



## Projection lens selection

The pattern drawing which has to be projected must be inscribed in a 11 mm diameter circle, same diagonal of a 2/3" detector.

For example, the pattern drawing could cover the entire 11 mm diameter area or be like a 8.8 x 6.6 mm rectangle or, again, be a square whose side is 7.78 mm.

Unless the projection optics introduces significant distortion, the shape of the projected pattern will preserve the features and aspect ratio of the engraved pattern. The projected area dimensions will be "M" times the original dimensions of the pattern, where M is the optical magnification at which the selected projection lens is operating. LTPR series can integrate most types of high resolution lenses: any high resolution C-mount lens for 2/3" detectors (11 mm image diagonal) can be used such as the ones included in our RT series.

Telecentric lenses for 2/3" detectors can also be interfaced, thus providing telecentric projection of the pattern and enabling unparalleled performances in 3D measurement applications. C-mount lenses and telecentric optics can be connected to the unit by means of the mount adaptor included in the product package. Here is a list of the projection diameters and the recommended projection distances with different types of optics.

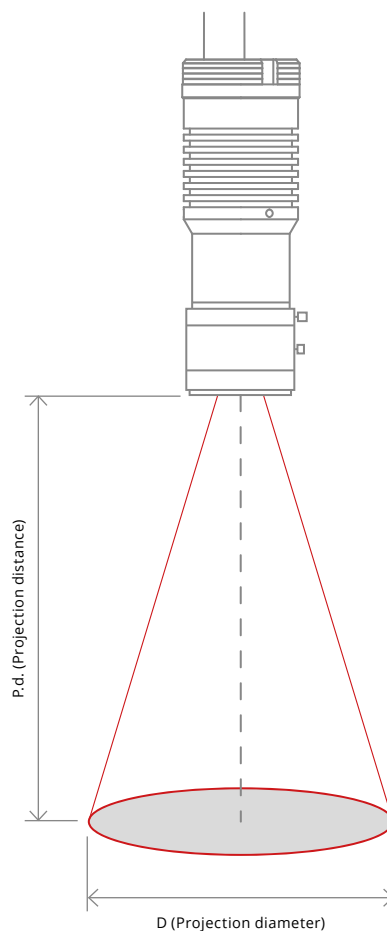
### Telecentric lenses

	TC 23 004	TC 23 007	TC 23 009	TC 23 016	TC 23 024	TC 23 036
P.d. (mm)	57.1	61.2	63.3	45.3	69.2	103.5
D (mm)	5.5	8.3	11.0	20.8	31.4	45.2
	TC 23 048	TC 23 056	TC 23 064	TC 23 072	TC 23 080	TC 23 096
P.d. (mm)	134.6	159.3	182.3	227.7	227.7	279.6
D (mm)	59.8	70.0	80.0	89.9	99.7	117.8

### 2 / 3" C-mount lenses

P.d.	@50	@75	@100	@150	@200	@250	@300	@400	@500
	mm	mm	mm	mm	mm	mm	mm	mm	mm
Focal length	D (Projection diameter) (mm)								
6 mm	81	127	172	264					
8 mm	58 (*)	92	127	195	264	333			
12 mm	35 (*)	58 (*)	81	127	172	218	264		
16 mm		41 (*)	58 (*)	92 (*)	127	161	195	264	333
25 mm				55 (*)	77 (*)	99 (*)	121 (*)	165	209 (*)
35 mm						68 (*)	83 (*)	115	146

(\*) = spacers may be needed to compensate back focal length



# LTPRXP series

High-power LED pattern projectors

**NEW**




## KEY ADVANTAGES

### Superior optical throughput


For large targets illumination and fast 3D scanning; minimal sensitivity to ambient light.

### Perfectly sharp edges

LTPR series ensures thinner lines, sharper edges and more homogeneous illumination than lasers.



With laser emitters the illumination decays both across the line cross section and along the line width.



Laser emitters lines are thicker and show blurred edges; diffraction and speckle effects are also present.

### Easy LED source replacement.



**LTPRXP series** pushes the light output of LTPR LED pattern projectors to extremely high values, making these products the solution of choice for 3D measurement of large objects.

Thanks to the illuminance these projectors can be used as a viable alternative to laser line generators in high-speed, on-line, linescan camera-based applications.

The high power can also be used in order to decrease system sensitivity to ambient light, for example, to perform 3D mapping of objects with illumination levels found in typical working environments.

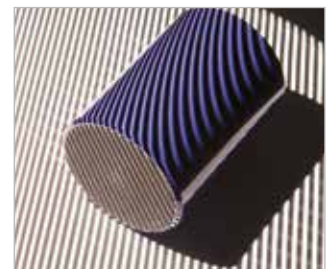
## Examples of setup and applications



3D reconstruction



Visualization & mapping



## Every kind of shape can be projected

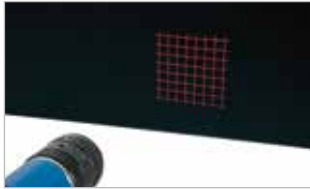
### Standard patterns



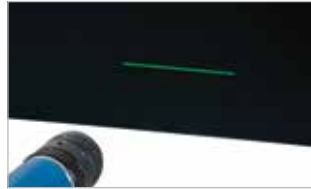
Stripe 0.5 mm line thickness



Edge

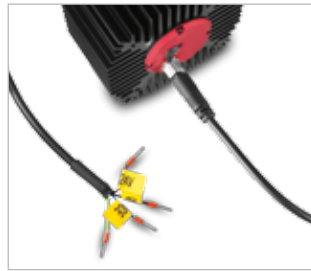
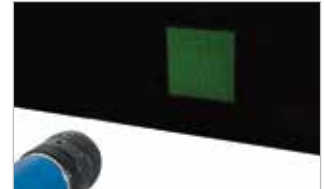


Grid 0.05 mm line thickness



Line 0.5 mm line thickness

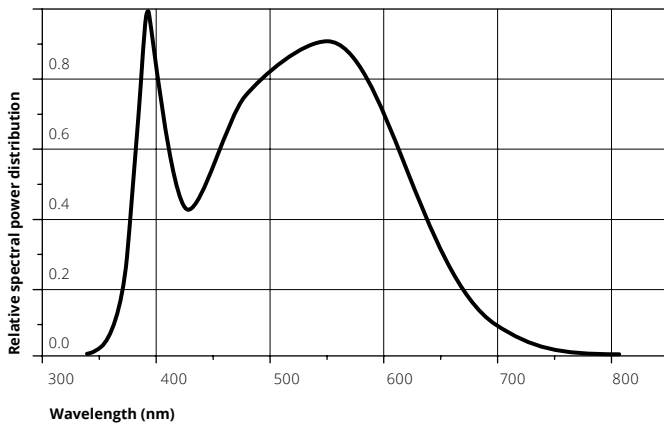
### Custom patterns



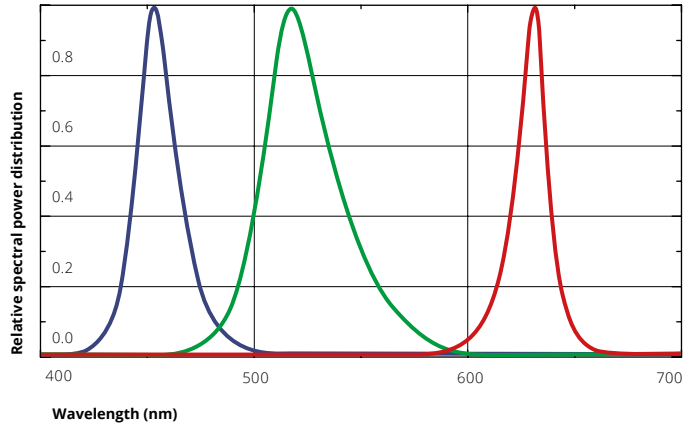
### Electrical features

These LED projectors integrate built-in switching electronics that control the current flow through the LED source and can be easily tuned thanks to the trimmer positioned in the back of the unit. The large heat sink ensures long lifetime at the highest power rates for the LED module and driving electronics. The LED source can also be easily serviced and replaced.

### Typical emission spectrum of white LEDs



### Typical emission spectrum of R,G,B LEDs

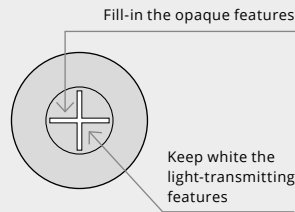
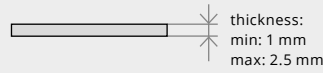
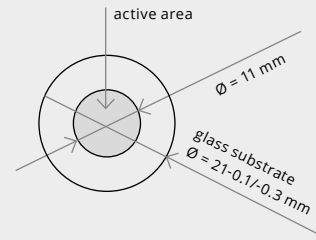
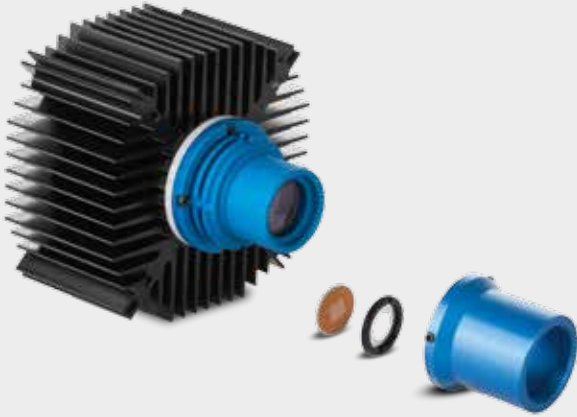


Part number	Light	Device power ratings			Compatible products
	Light color, wavelength peak	DC Voltage (V)	Power consumption (W)	Illuminance (kLux) 1	
LTPRXP-R	red, 630 nm	24	< 13	40	RT series
LTPRXP-G	green, 520 nm	24	< 13	68	RT series
LTPRXP-B	blue, 460 nm	24	< 13	9	RT series
LTPRXP-W	white	24	< 13	85	RT series

1 With a 35 mm lens, F/# 1.4 at 100 mm working distance without projection pattern.

# LTPRXP series

## Product insight



### Custom-made pattern

Custom-made patterns can be supplied on request. A drawing with accurate geometrical information must be submitted (please refer to the instructions here below).

### Photolithography patterns

**PT 0000 0100 P**  
design: line pattern  
line thickness 0.05 mm

**PT 0000 0200 P**  
design: cross pattern  
line thickness 0.05 mm

**PT 0000 0300 P**  
design: stripe pattern  
line gap 0.95 mm  
line thickness 0.05 mm

**PT 0000 0400 P**  
design: grid pattern  
line gap 0.95 mm  
line thickness 0.05 mm

**PT 0000 0500 P**  
design: edge pattern  
line gap 0.10 mm  
line thickness 0.05 mm

### Laser engraved patterns

**PT 0000 0100 L**  
design: line pattern  
line thickness 0.5 mm

**PT 0000 0200 L**  
design: cross pattern  
line thickness 0.5 mm

**PT 0000 0300 L**  
design: stripe pattern  
line gap 0.5 mm  
line thickness 0.5 mm

**PT 0000 0400 L**  
design: grid pattern  
line gap 0.8 mm  
line thickness 0.2 mm

**PT 0000 0500 L**  
design: edge pattern  
line gap 0.10 mm  
line thickness 0.5 mm

### Pattern selection

The projection pattern can be easily integrated into the LTPR projection unit by unscrewing the retaining ring that holds the pattern itself.

This simple procedure makes it easy to interchange different patterns on the same projection unit. The pattern outer diameter is 21 mm, while the active projection area is a circle of Ø 11 mm: all the significant features of the pattern are drawn inside this circle.

The projection area will have the same aspect ratio as the pattern. The projection accuracy depends both on the pattern manufacturing accuracy and lens distortion. The edge sharpness of the projected pattern depends on both the lens resolution and the engraving technique: laser-engraved patterns (part numbers ending in "L") or photolithography-engraved patterns (part numbers ending in "P") can be chosen depending on the type of application.

#### Pattern specifications

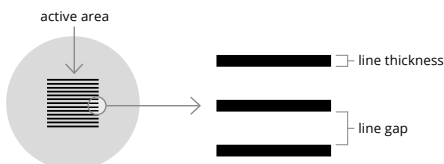
##### Photolithography patterns

<b>Substrate</b>	Soda lime glass
<b>Coating</b>	Chrome
<b>Geometrical accuracy</b>	2 µm
<b>Edge sharpness</b>	1.4 µm

##### Laser engraved patterns

<b>Substrate</b>	Borofloat glass
<b>Coating</b>	Dichroic mirror
<b>Geometrical accuracy</b>	50 µm
<b>Edge sharpness</b>	50 µm

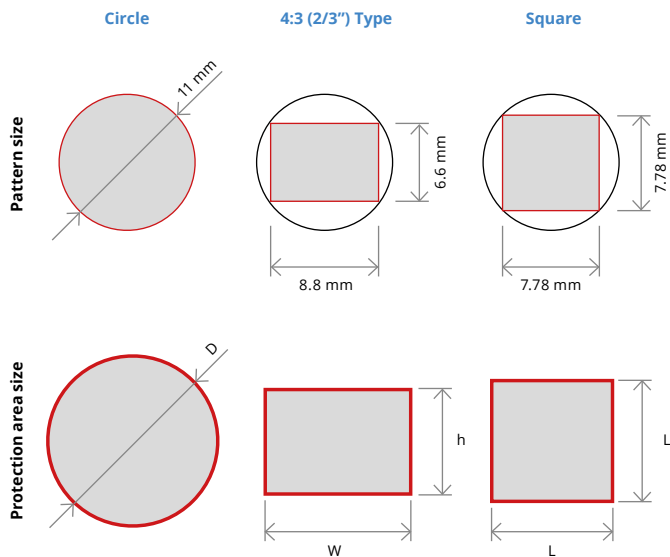
### Pattern detail



### RT SERIES

Full range of compatible optics available.  
Visit [www.opto-engineering.com/rt-series](http://www.opto-engineering.com/rt-series) to select the most appropriate C-mount fixed focal length optics.





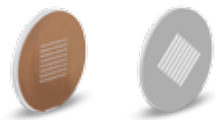
## Projection lens selection

The pattern drawing must be inscribed in a 11 mm diameter circle, same diagonal of a 2/3" detector. For example, the pattern drawing could cover the entire 11 mm diameter area or be shaped as a 8.8 x 6.6 mm rectangle or also a square of 7.78 mm side length.

Unless the projection optics introduces significant distortion, the shape of the projected pattern will preserve the features and aspect ratio of the engraved pattern. The projected area size will be equal to  $1/M$ , where "M" stands for the magnification factor of the lens when used as a standard viewing objective.

LTPRXP series can integrate high resolution C-mount lenses for 2/3" detectors (11 mm image diagonal), using the mount adaptor included in the product package. Here is a list of the projection diameters and the recommended projection distances with different types of optics.

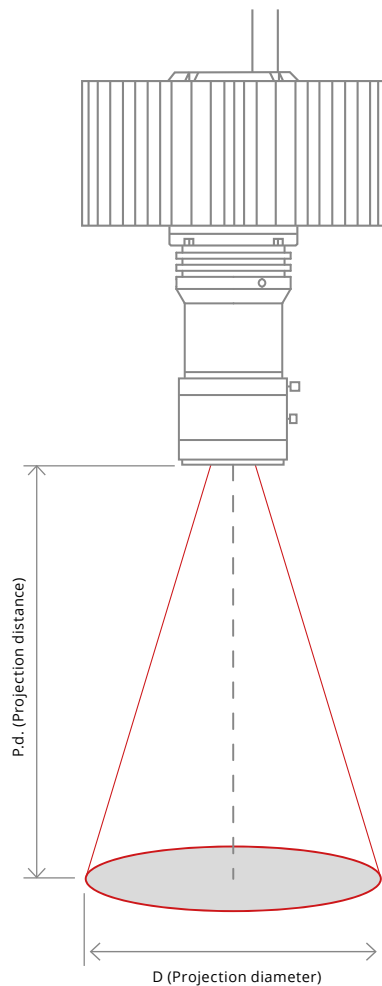
## Accessories / Compatibility



Patterns



Standard C-mount lenses



## 2 / 3" C-mount lenses

P.d.	@50	@75	@100	@150	@200	@250	@300	@400	@500
	mm	mm	mm	mm	mm	mm	mm	mm	mm
<b>Focal length</b>	<b>D (Projection diameter)</b>								
	(mm)								
6 mm	81	127	172	264					
8 mm	58 (*)	92	127	195	264	333			
12 mm	35 (*)	58 (*)	81	127	172	218	264		
16 mm		41 (*)	58 (*)	92 (*)	127	161	195	264	333
25 mm				55 (*)	77 (*)	99 (*)	121 (*)	165	209 (*)
35 mm						68 (*)	83 (*)	115	146

(\*) = spacers may be needed to compensate back focal length

# Infrared optics

Beyond the visible range,  
for advanced optical applications.

Opto Engineering offers a wide variety of **high resolution IR optics** for both cooled and uncooled IR cameras spanning all IR spectral bands. Our IR optics feature large field of view and low distortion and can be equipped with custom mount interface. MWIR and LWIR thermal series additionally include HCAR coating for usage in harsh environment.

IR optics are used in a wide variety of sectors including defense, security/surveillance, industrial, medical and R&D. Applications include tracking/targeting systems, predictive maintenance, monitor of hot industrial processes, thermography, flame detection, quality control /inspection.



# SWIR series

## Short-wave infrared lenses



**KEY ADVANTAGES**

**High resolution**

Designed for high resolution detectors up to 15 µm pixel pitch and 21 mm diameter.

**Custom mount interface**

Can be provided upon request.

**Large field of view and low distortion**

Superior optical performances.

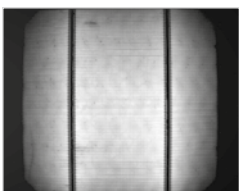
**SWIR series** is a range of **short-wave infrared lenses** specifically designed to operate in the 0.9-1.7 µm wavelength region. This series has been specifically designed to match the new 15 µm format InGaAs FPA Focal Plane Arrays.

These lenses offer an industry standard C-mount threaded style interface or, alternatively, they can be equipped with a custom mount interface.

In the design of the lenses, great importance was attached to a good image quality and a large aperture (small F-number).

These lenses, mounted on a SWIR camera, are the perfect choice for a variety of applications, including solar cell inspection, night vision imaging of outdoors scenes without additional illumination (security applications), detecting bruises on fruit, imaging through silicon, biomedical imaging and many other infrared applications.

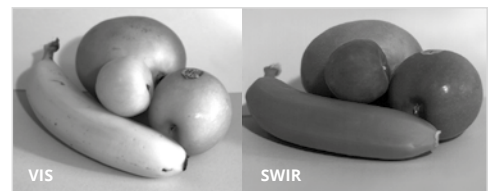
**Application examples**



Solar cell inspection



Liquid level inspection



Fruit sorting

Part number	Optical specifications										Mechanical specifications						
	Focal length	F/#	Wave length	Average trans.	Circular FOV	WD	Image Diagonal	Distortion	CTF @ 30lp/mm	Image side NA	Mount	Focus type	Locking screw	Back focal length	Length	Diam.	Mass
	(mm)		(µm)	(%)	(deg)	(mm)	(mm)	(%)	(%)				(mm)	(mm)	(mm)	(g)	
<b>SW03520</b>	35.00	2.0	0.9-1.7	90	33.4	350 - ∞	21.0	-0.50	39.09	0.243	C	Manual	Yes	12.16	49.34	71	340
<b>SW05020</b>	50.00	2.0	0.9-1.7	90	23.7	500 - ∞	21.0	0.41	43.09	0.243	C	Manual	Yes	14.07	71.00	71	400
<b>SW07520</b>	75.00	2.0	0.9-1.7	90	15.9	750 - ∞	21.0	0.50	30.19	0.243	C	Manual	Yes	14.10	101.20	71	540

1 Based on the listed image diagonal.  
 2 Maximum value at central wavelength.  
 3 Mean value at all the different fields.

4 Any custom mount is available at no additional cost. B = Bayonet mount type.  
 5 Measured from the front end of the mechanics to the camera flange.  
 6 Given with no mount attached. See layout drawings.

# MWIR series

Medium-wave infrared lenses



**KEY ADVANTAGES**

**High resolution**

Designed for high resolution detectors up to 15  $\mu\text{m}$  pixel pitch and 21 mm diameter.

**Custom mount interface**

Can be equipped with any custom mount interface.

**Large field of view and low distortion**

Superior optical performances.

**HCAR coating**

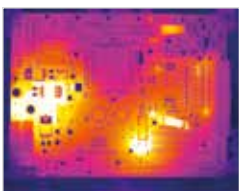
For applications exposing optical elements to harsh environments.

**MWIR series** is a range of **medium-wave infrared lenses** specifically designed to operate in the 3-5  $\mu\text{m}$  wavelength region with InSb Focal Plane Arrays (FPA). The lenses offer a standard Bayonet interface or, alternatively, they can be equipped with a custom mount interface.

In the design of the lenses, great importance was attached to a good image quality and a large aperture (small F-number).

These lenses, mounted on a MWIR camera, are the perfect choice for a variety of applications, including imaging through fog, high-speed thermal imaging, thermography, R&D (MWIR range), non-destructive testing.

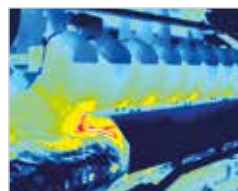
**Application examples**



Electronic boards inspection



Thermal imaging



Automotive

Part number	Optical specifications										Mechanical specifications						
	Focal length	F/#	Wave length	Average trans.	Circular FOV	WD	Image Diagonal	Distortion	CTF @ 30lp/mm	Image side NA	Mount	Focus type	Locking screw	Back focal length	Length	Diam.	Mass
	(mm)		( $\mu\text{m}$ )	(%)	(deg)	(mm)	(mm)	(%)	(%)					(mm)	(mm)	(mm)	(g)
<b>MW03523</b>	35.00	2.3	3.0-5.0	90	33.4	350 - $\infty$	21.0	-0.20	39.68	0.212	B/Custom	Manual	Yes	32.45	57.69	71	263
<b>MW05023</b>	50.00	2.3	3.0-5.0	90	23.7	500 - $\infty$	21.0	-0.20	57.02	0.212	B/Custom	Manual	Yes	34.44	55.70	71	245
<b>MW07523</b>	75.00	2.3	3.0-5.0	90	15.9	750 - $\infty$	21.0	-0.20	56.86	0.212	B/Custom	Manual	Yes	57.14	57.02	84	335
<b>MW10023</b>	100.00	2.3	3.0-5.0	90	12.0	1000 - $\infty$	21.0	-0.20	61.01	0.212	B/Custom	Manual	Yes	52.00	90.51	108	1060

1 Based on the listed image diagonal.  
 2 Maximum value at central wavelength.  
 3 Mean value at all the different fields.

4 Any custom mount is available at no additional cost. B = Bayonet mount type.  
 5 Measured from the front end of the mechanics to the camera flange.  
 6 Given with no mount attached. See layout drawings.

# LWIR series

Long-wave infrared lenses



**KEY ADVANTAGES**

**High resolution**

Designed for high resolution detectors up to 15 μm pixel pitch and 21 mm diameter.

**Custom mount interface**

Can be equipped with any custom mount interface.

**Large field of view and low distortion**

Superior optical performances.

**HCAR coating**

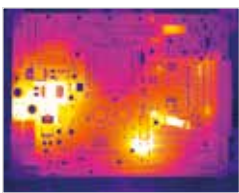
For applications exposing optical elements to harsh environments.

**LWIR series** is a range of **long-wave infrared lenses** specifically designed to operate in the 8-14 μm wavelength region with uncooled detectors (a-Si, VOx, ...).

In the design of the lenses great importance was assigned to high image quality and large aperture (small F-number). These lenses can also be equipped with custom mount interfaces.

These lenses, mounted on an uncooled LWIR camera are the perfect choice for a variety of applications spanning from industrial to military, including temperature measurement for process quality control and monitoring, predictive maintenance, imaging through smoke and fog, medical imaging.

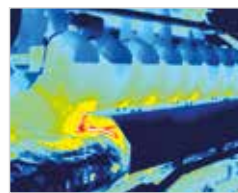
**Application examples**



Electronic boards inspection



Thermal imaging



Automotive

**Optical specifications**

**Mechanical specifications**

Part number	Optical specifications										Mechanical specifications						
	Focal length (mm)	F/#	Wave length (μm)	Average trans. (%)	Circular FOV (deg)	WD (mm)	Image Diagonal (mm)	Distortion (%)	CTF @ 30lp/mm (%)	Image side NA	Mount	Focus type	Locking screw	Back focal length (mm)	Length (mm)	Diam. (mm)	Mass (g)
<b>LW03514</b>	35.00	1.4	8.0-14.0	90	33.4	350 - ∞	21.0	0.20	44.99	0.336	Custom	Manual	Yes	11.88	57.62	71	300
<b>LW05014</b>	50.00	1.4	8.0-14.0	90	23.7	500 - ∞	21.0	0.20	40.70	0.336	Custom	Manual	Yes	18.00	51.50	71	300
<b>LW07514</b>	75.00	1.4	8.0-14.0	90	15.9	750 - ∞	21.0	0.20	38.43	0.336	Custom	Manual	Yes	14.63	106.41	85	850

1 Based on the listed image diagonal.  
 2 Maximum value at central wavelength.  
 3 Mean value at all the different fields.

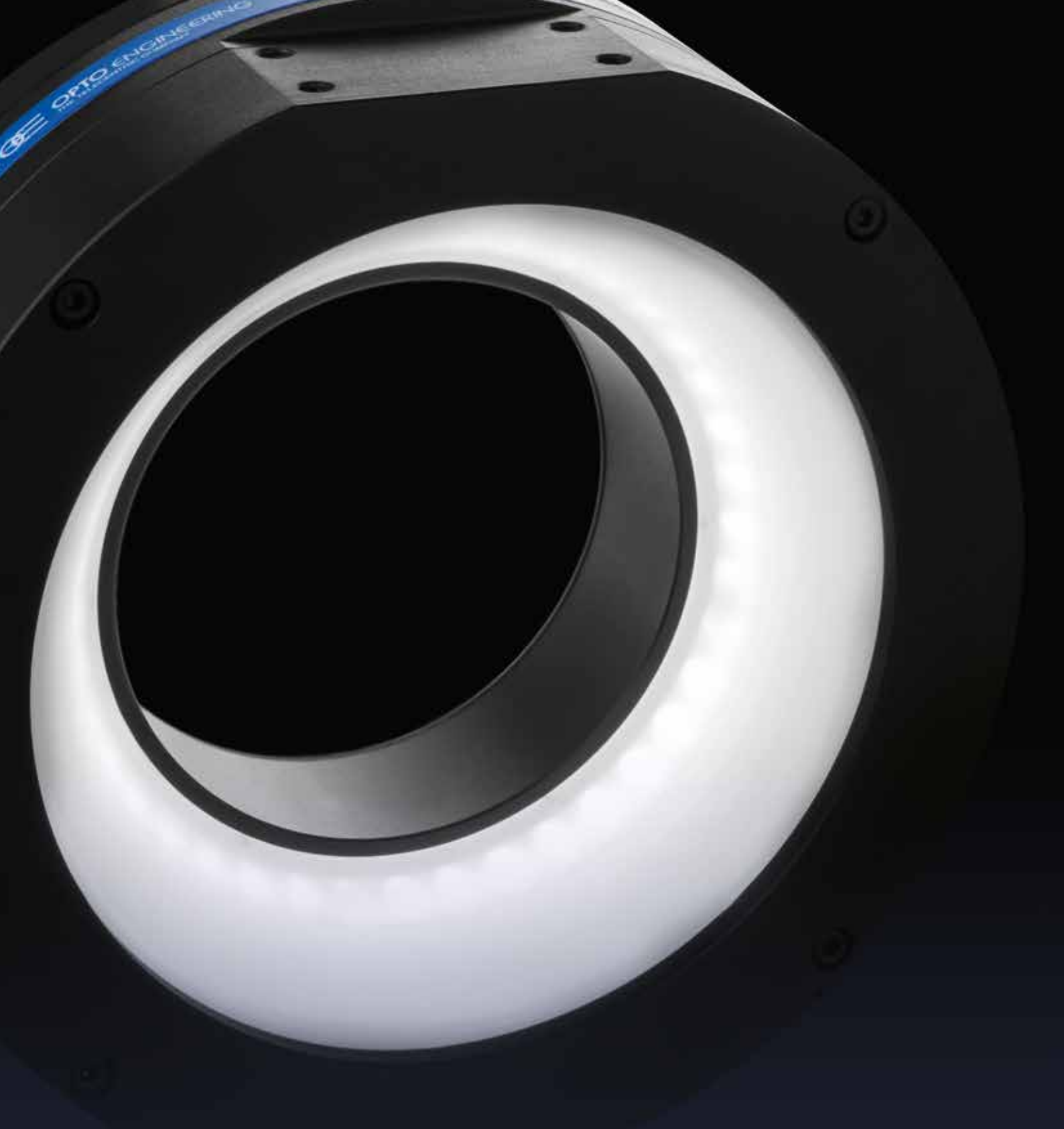
4 Any custom mount is available at no additional cost. B = Bayonet mount type.  
 5 Measured from the front end of the mechanics to the camera flange.  
 6 Given with no mount attached. See layout drawings.

## Advanced lighting solutions.

Illumination is a critical part of every machine vision setup: **proper choice of lighting color and geometry can be used to effectively mask or reveal different features of an object**, leading to a vastly simpler and accurate image processing stage.

**Opto Engineering offers a wide range of illumination solutions** including ring lights, dome illuminators and a unique space-saving lighting system complemented by specific power/strobe controllers. The Opto Engineering illuminators family provides innovative and robust lighting units, **designed to deal with fast-moving objects of varying sizes and surface types**, such as highly reflective or curved samples.





# Illuminators



# LTRN series

LED ring illuminators



#### KEY ADVANTAGES

**Mechanically fitting Opto Engineering optics**  
Each lens integrates specific mechanical interfaces.

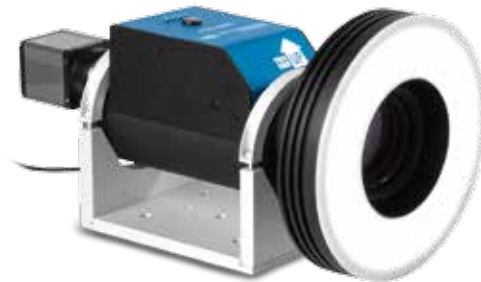
**Specific illumination geometry**  
Illumination path matches Opto Engineering lenses viewing angle and numerical aperture.

**High performance to price ratio**  
Cost-effective, without quality compromises.

**LTRN series are LED ring illuminators** specifically designed for a wide range of Opto Engineering products.

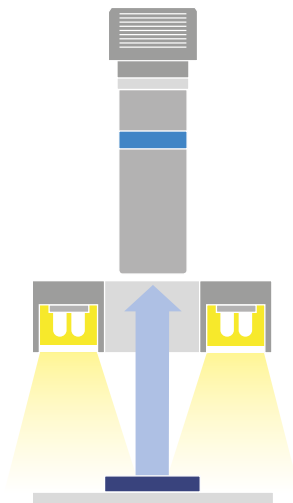
Every illuminator is equipped with a mechanical interface which makes it very easy to mount it on different lens types.

These products enable the optimal illumination geometry for the most common applications of their matching lens.

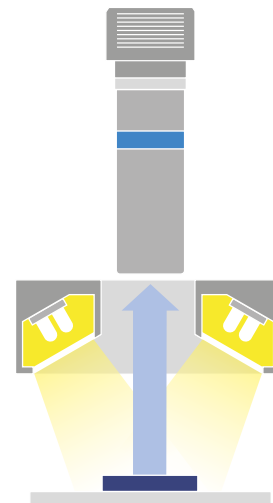


LTRN illuminator coupled with TCZR series.

#### Lighting structure



LTRN - Ring lights / straight illumination (-NW)



LTRN - Ring lights / oblique illumination





## Product overview



LTRN 016 NW



LTRN 050 W45



LTRN 075 W45



LTRN 120 NW



LTRN 165 W45



LTRN 245 W45

Part number	Compatibility	Light	Dimensions			Power ratings	
	Opto Engineering optics	Colour, peak wavelength	Outer diameter (mm)	Inner diameter (mm)	Height (mm)	Voltage (V, DC)	Power (W)
	<b>Straight illumination</b>						
LTRN 023 NW	TC2300y, TC23012, TC4M00y-x, MC3-03X	white, 6300K	104.0	28.0	40.0	24	12
LTRN 016 NW	TCxx016, TCxMHR016-x, TCxSM016, TCLWD series	white, 6300K	120.6	37.7	40.0	24	15
LTRN 024 NW	TCxx024, TCxMHR024-x, TCxSM024	white, 6300K	120.6	44.0	40.0	24	15
LTRN 036 NW	TCxx036, TCxMHR036-x, TC16M036-x, TCxSM036, MCZRxxx-yyy	white, 6300K	157.0	61.0	40.0	24	25
LTRN 048 NW	TCxx048, TCxMHR048-x, TC16M048-x, TCxSM048	white, 6300K	157.0	75.0	40.0	24	25
LTRN 056 NW	TCxx056, TCxMHR056-x, TC16M056-x, TCxSM056, TCZR072	white, 6300K	157.0	80.0	40.0	24	25
LTRN 064 NW	TCxx064, TCxMHR064-x, TC16M064-x, TC12K064, TCxSM064	white, 6300K	192.0	100.0	40.0	24	38
LTRN 080 NW	TCxx080, TC23072, TCxMHR080-x, TC16M080-x, TC12K080, TCxSM080	white, 6300K	192.0	116.0	40.0	24	38
LTRN 096 NW	TCxx096, TC23085, TCxMHR096-x, TC16M096-x, TCxSM096	white, 6300K	221.0	143.0	40.0	24	38
LTRN 120 NW	TCxx120, TC23110, TCxMHR120-x, TC16M120-x, TC12K120	white, 6300K	290.0	180.0	40.0	24	45
LTRN 144 NW	TCxx144, TC23130, TCxMHR144-x, TC16M144-x, TC12K144	white, 6300K	290.0	200.0	40.0	24	45
	<b>Oblique illumination</b>						
LTRN 050 W45	PCPW0xx, MCxxxX, TCCAGExx048	white, 6300K	53.5	15.2	22.0	24	2.5
LTRN 075 W45	TC2300y, TC23012, TC4M00y-x, PCHI0xx, TCCAGExx096, MC3-03X	white, 6300K	75.4	28.0	32.0	24	3
LTRN 165 W45	PCCD0xx	white, 6300K	175.0	132.0	36.5	24	18
LTRN 210 W20	PCxx030XS	white, 6300K	210.0	116.5	40.0	24	38
LTRN 245 W25	PCxx030HP	white, 6300K	245.0	157.0	48.0	24	30
LTRN 245 W35	PCCD0xx	white, 6300K	245.0	143.0	48.0	24	30
LTRN 245 W45	PCPW0xx	white, 6300K	245.0	117.0	48.0	24	30

# LTBC series

LED Backlight illuminators



## KEY ADVANTAGES

### Cost-effective homogeneous illumination

Densely packed LED arrays with matt diffuser eliminating hot spots and glare.

### Robust industrial Design

M8 connector for easy connection to power supplies.

### Easy integration

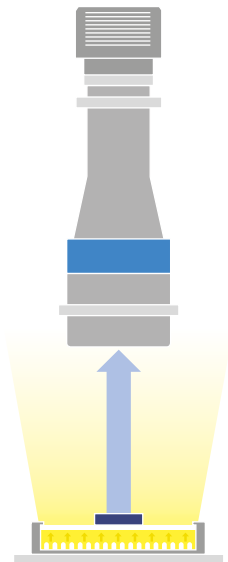
M6 nut channels for easy mounting.

**LTBC series** are LED backlights designed to be employed in a wide variety of applications such as shape and size inspection of workpieces.

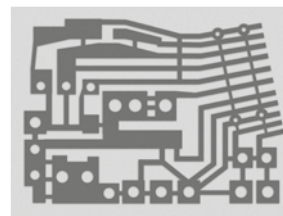
These backlights are a cost-effective solution without quality compromise: they feature a robust design and provide diffused homogeneous illumination without hotspot formation.

When installed behind the workpiece LTBC series effectively emphasize its silhouette providing excellent optical contrast in combination with many different lenses.

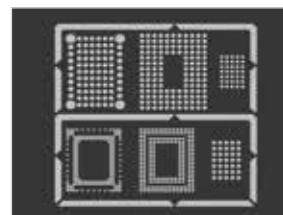
## Lighting structure



## Application examples



Shape inspection



Detection of patterns/holes



LTBC114114-G



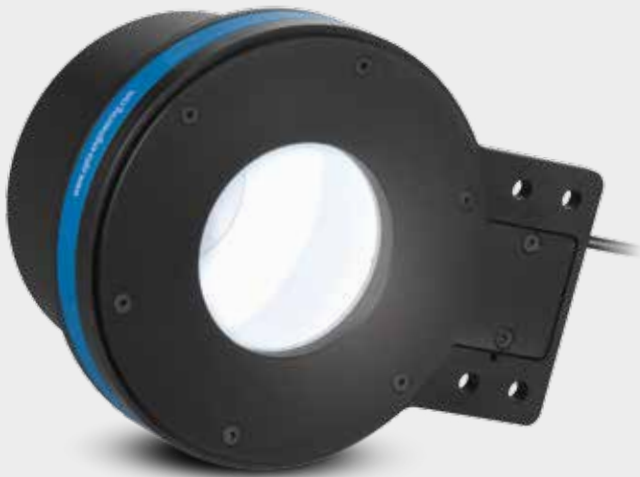
LTBC054054 with M6 threaded hole for easy mounting.

Part number	Optical specifications			Electrical specifications					Dimensions			Compatibility Opto Engineering optics
	Colour, peak wavelength	Lighting area		Continuous mode			Pulsed mode		Length (mm)	Width (mm)	Height (mm)	
		Length (mm)	Width (mm)	Supply Voltage (V)	Current (mA)	Power cons. (W)	Supply Voltage (V)	Max pulse Current (mA)				
LTBC054054-W	white, 6300K	54.5	54.5	24	54	1.30	36	162	99	99	35.6	TC2300y, TC23012, TCxx016, TCxx024, TCxx036, TCLWD series, TCxMHR016-x, TCxMHR024-x, TCxMHR036-x, TC4M00y-x, TC16M009-x, TC16M012-x, TC16M018-x, TC16M036-x, TCZR036, MC series, MC4K050X-x, MC4K100X-x, MC4K125X-x, MC4K150X-x, MC4K175X-x, MC4K200X-x, MC12K200X-x, MC12K150X-x, MC12K100X-x
LTBC054054-G	green, 525nm	54.5	54.5	24	54	1.30	36	162	99	99	35.6	TCxx048 - TCxx085, TCxMHR048-x, TCxMHR056-x, TCxMHR064-x, TCxMHR080-x, TC16M048-x, TC16M056-x, TC16M064-x, TC16M080-x, TCZR072, MC4K025X-x, MC12K067X-x, MC12K050X-x
LTBC114114-W	white, 6300K	114.5	114.5	24	216	5.18	36	648	159	159	35.6	TCxx096 - TCxx130, TCxMHR096-x, TCxMHR120-x, TC16M096-x, TC16M120-x, TCDPxx096, TCDPxx120, MCZR033-008, MC12K025X-x
LTBC114114-G	green, 525nm	114.5	114.5	24	216	5.18	36	648	159	159	35.6	TCxx144, TC23172, TCxMHR144-x, TC16M144-x, TC16M192-x, TCDPxx144, MCZR025-006, MCZR018-004
LTBC174174-W	white, 6300K	174.5	174.5	24	486	11.66	36	1458	219	219	35.6	TCxx144, TC23172, TCxMHR144-x, TC16M144-x, TC16M192-x, TCDPxx144, MCZR025-006, MCZR018-004
LTBC174174-G	green, 525nm	174.5	174.5	24	486	11.66	36	1458	219	219	35.6	TCxx144, TC23172, TCxMHR144-x, TC16M144-x, TC16M192-x, TCDPxx144, MCZR025-006, MCZR018-004
LTBC234234-W	white, 6300K	234.5	234.5	24	864	20.74	36	2592	279	279	35.6	TCxx144, TC23172, TCxMHR144-x, TC16M144-x, TC16M192-x, TCDPxx144, MCZR025-006, MCZR018-004
LTBC234234-G	green, 525nm	234.5	234.5	24	864	20.74	36	2592	279	279	35.6	TCxx144, TC23172, TCxMHR144-x, TC16M144-x, TC16M192-x, TCDPxx144, MCZR025-006, MCZR018-004

# LTDM series

Diffusive strobed dome illuminators

**NEW**



#### KEY ADVANTAGES

**Ultra-high power light output and strobe mode only operation**  
For the inspection of fast moving object and extended LED lifetime.

**Rugged industrial design with built-in industrial connector**  
For easy integration into any machine vision system.

**Wide selection**  
Available in three sizes, three colors and two power intensities.

**Compatible LTDV strobe controllers available**  
For easy and appropriate power, control and synchronization of the illuminator.

**LTDM series** are high power diffusive LED strobed dome illuminators designed to provide non-directional diffused light and to effectively eliminate glares and shadows.

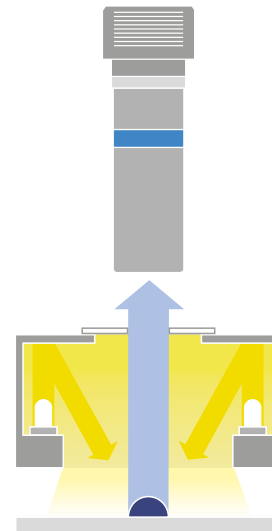
LTDM series provides ultra-high power light output and can be used to illuminate complex shapes with curved and shiny surfaces. LTDM dome illuminators can be exclusively operated in strobe mode, making them the perfect choice to illuminate very fast moving objects while ensuring extended LED lifetime since no heat is generated.

LTDM series can be easily powered, controlled and synchronized by compatible LTDV strobe controllers and is available in:

- **three sizes:** small, medium and large, respectively with illumination area of 40 mm, 60 mm and 100 mm in diameter;
- **two power intensities:** medium power with driving current up to 7.5 A and high power with driving current up to 17 A;
- **three different colors:** white, red and green.

LTDM series feature industry standard connection (M8 or M12 four poles connector) and resizable aperture that can be drilled to increase the diameter and accommodate the optics field of view. Additionally they can be easily integrated into any machine vision system by means of M6 screws.

#### Lighting structure



DESIGNED FOR OEM APPLICATIONS

Compatible LTDV strobe controllers available to easily power, control and synchronize LT illuminators.



Part number		LTDMA1-W	LTDMA1-G	LTDMA1-R	LTDMB2-W	LTDMB2-G	LTDMB2-R	LTDMC1-W	LTDMC2-W	LTDMC2-G	LTDMC2-R	
<b>Optical specifications</b>												
Number of LEDs		15	15	15	40	40	40	40	80	80	80	
Light colour		white, 6000 K	green, 525 nm	red, 625 nm	white, 6500K	green, 528 nm	red, 625 nm	white	white, 6500K	green, 528 nm	red, 625 nm	
Spectral FWHM	(nm)	n.a.	50	25	n.a.	35	20	n.a.	n.a.	35	20	
Illumination area diameter	(mm)	40	40	40	60	60	60	100	100	100	100	
Suggested working distance WD	(mm)	5 - 50	5 - 50	5 - 50	5 - 50	5 - 50	5 - 50	5 - 50	5 - 50	5 - 50	5 - 50	
Min estimated illumination <sup>1</sup>	At driving current = 3.5 A	(klux)	100	70	40	50	45	35	25	50	45	35
	At driving current = 7.5 A	(klux)	175	125	70	90	80	65	50	100	90	70
	At driving current = 17.0 A	(klux)	n.a.	n.a.	n.a.	160	145	115	70	140	125	100
Aperture range	(mm)	38 (fixed)	38 (fixed)	38 (fixed)	10 - 50	10 - 50	10 - 50	10 - 60	10 - 60	10 - 60	10 - 60	
<b>Electrical specifications</b>												
Power supply mode		strobe only, constant current driving			strobe only, constant current driving			strobe only, constant current driving				
Driving current	Min	(A)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	
	Max	(A)	7.5	7.5	7.5	17.0	17.0	17.0	7.5	17.0	17.0	
Pulse width <sup>2</sup>	(ms)	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	
Connection Type <sup>3</sup>		M8 industrial male connector			M12 industrial male connector			M12 industrial male connector				
Estimated MTBF <sup>4</sup>	(hours)	> 50000	> 50000	> 50000	> 50000	> 50000	> 50000	> 50000	> 50000	> 50000	> 50000	
<b>Mechanical specifications</b>												
Dimensions	Length	(mm)	107	107	107	166.5	166.5	166.5	206	206	206	
	Width	(mm)	84	84	84	133	133	133	206	206	206	
	Height	(mm)	53	53	53	90	90	90	128	128	128	
Materials		black anodized aluminum body			black anodized aluminum body			black anodized aluminum body / painted steel reflector				
Clamping system		4 threaded holes for M6 screw			4 holes for M6 screw			4 threaded holes for M6 screw				
<b>Compatibility</b>												
Strobe controllers		LTDV1CH-7, LTDV6CH			LTDV1CH-17, LTDV6CH			LTDV1CH-7, LTDV6CH	LTDV1CH-17, LTDV6CH			
Lenses		TC23007, TC23009, TCLWD series, MC050X, MC033X, RT series			TCLWD series, MC033X, RT series			TCLWD series, RT series, MC4K050X-x, MC4K075X-x				

- <sup>1</sup> At max Working Distance WD
- <sup>2</sup> At 25°C. At max pulse width (1 ms), max pulse frequency = 15 Hz.
- <sup>3</sup> 5 m cable with straight female connector included. Optional cable with right angled connector is also available and must be ordered separately (refer to our website for further info and ordering codes).
- <sup>4</sup> At 25°C.

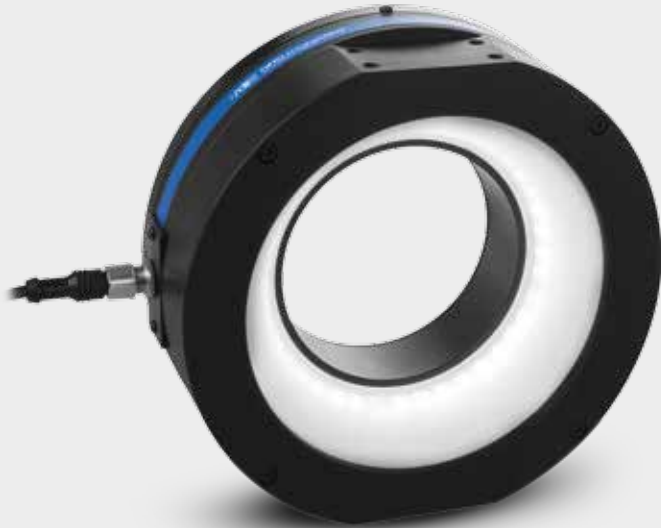
#### Ordering information

It's easy to select the right illuminator for your application: our part numbers are coded as **LTDM xy-z**, where **x** defines the illuminator size (A = small, B = medium, C = large), **y** refers to the power intensity (1 = medium, 2 = high) and **z** refers to color (W = white, R = red, G = green). For instance LTDM B2-R is a diffusive strobed dome illuminator - medium size high power red.

# LTLA series

Diffusive strobed low angle ring light illuminators

**NEW**



## KEY ADVANTAGES

**Ultra-high power light output and strobe mode only operation**  
For the inspection of fast moving object and extended LED lifetime.

**Rugged industrial design with built-in industrial connector**  
For easy integration into any machine vision system.

**Wide selection**  
Available in two sizes, three colors and two power intensities.

**Compatible LTDV strobe controllers available**  
For easy and appropriate power, control and synchronization of the illuminator.

**Low angle beam shaping diffuser**  
Highly diffusive material avoids hot spots formation and ensures uniform light intensity.

**LTLA series** are high power diffusive LED strobed low-angle ring light illuminators designed to provide darkfield lighting and to effectively enhance minute surface features or textures.

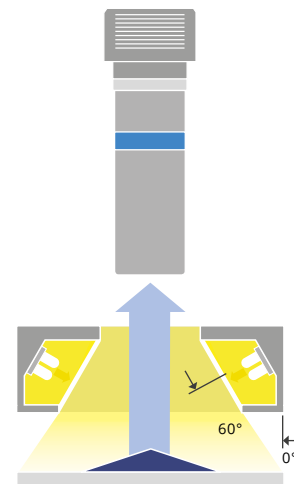
LTLA series features ultra-high power light output and can be used to cast shadows that emphasize surface irregularities, scratches or special characteristics (such as bar codes) from a close distance. LTLA low angle ring illuminators can be exclusively operated in strobe mode, making them the perfect choice to illuminate very fast moving objects while ensuring extended LED lifetime since no heat is generated.

LTLA series can be easily powered, controlled and synchronized by compatible LTDV strobe controllers and is available in:

- **two sizes:** medium and large, respectively with illumination area of 60 mm and 100 mm in diameter;
- **two power intensities:** medium power with driving current up to 7.5 A and high power with driving current up to 17 A;
- **three different colors:** white, red and green.

LTLA series feature industry standard connection (M12 four poles connector) and can be easily integrated into any machine vision system by means of M6 screws.

## Lighting structure



DESIGNED FOR OEM APPLICATIONS

Compatible LTDV strobe controllers available to easily power, control and synchronize LT illuminators.



Part number		LTLAB2-W	LTLAB2-G	LTLAB2-R	LTLAC1-W	LTLAC2-W	LTLAC2-G	LTLAC2-R	
<b>Optical specifications</b>									
Number of LEDs		40	40	40	40	80	80	80	
Light colour		white, 6000 K	green, 525 nm	red, 625 nm	white, 6500K	white, 6500K	green, 528 nm	red, 625 nm	
Spectral FWHM	(nm)	n.a.	35	20	n.a.	n.a.	35	20	
Diffusive ring		yes	yes	yes	yes	yes	yes	yes	
Illumination area diameter	(mm)	60	60	60	100	100	100	100	
Suggested working distance WD	(mm)	5 - 50	5 - 50	5 - 50	5 - 50	5 - 50	5 - 50	5 - 50	
Min estimated illumination <sup>1</sup>	At driving current = 3.5 A	(klux)	55	50	40	35	70	60	45
	At driving current = 7.5 A	(klux)	105	90	70	70	140	120	90
	At driving current = 17.0 A	(klux)	210	180	150	125	250	220	170
Aperture range	(mm)	64 (fixed)	64 (fixed)	64 (fixed)	102 (fixed)	102 (fixed)	102 (fixed)	102 (fixed)	
<b>Electrical specifications</b>									
Power supply mode		strobe only, constant current driving			strobe only, constant current driving				
Driving current	Min	(A)	3.5	3.5	3.5	3.5	3.5	3.5	
	Max	(A)	17.0	17.0	17.0	7.5	17.0	17.0	
Pulse width <sup>2</sup>	(ms)	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	
Connection Type <sup>3</sup>		M12 industrial male connector			M12 industrial male connector				
Estimated MTBF <sup>4</sup>	(hours)	> 50000	> 50000	> 50000	> 50000	> 50000	> 50000	> 50000	
<b>Mechanical specifications</b>									
Dimensions	Length	(mm)	166.5	166.5	166.5	206	206	206	
	Width	(mm)	133	133	133	206	206	206	
	Height	(mm)	38	38	38	76	76	76	
Materials		black anodized aluminum body			black anodized aluminum body				
Clamping system		4 holes for M6 screw			8 threaded holes for M6 screw				
<b>Compatibility</b>									
Strobe controllers		LTDV1CH-17, LTDV6CH			LTDV1CH-7, LTDV6CH	LTDV1CH-17, LTDV6CH			
Lenses		TC2300y, TC23012, TC12016, TC23016, TC12024, TC23024, TCxx036, TC2MHR016-x, TC2MHR024-x, TC2MHR036-x, TC4M004-x, TC4M007-x, TC4M009-x, TC4MHR016-x, TC4MHR024-x, TC4MHR036-x, TC16M009-x, TC16M012-x, TC16M018-x, TC16M036-x, TCLWD series, TCZR036, MCZR033-008, MCZR025-006, MCZR018-004, MCZR014-003, MC150X, MC100X, MC075X, MC050X, MC033X, RT series, MC4K050X-x, MC4K075X-x, MC4K100X-x, MC4K125X-x, MC4K150X-x, PCHI0xx			TCxx036, TCxx048, TC12056, TC23056, TC13064, TCxx064, TC2MHR036-x, TC2MHR048-x, TC2MHR056-x, TC2MHR064-x, TC4MHR036-x, TC4MHR048-x, TC4MHR056-x, TC4MHR064-x, TC16M036-x, TC16M048-x, TC16M056-x, TC16M064-x, TC12K064, TCLW series, TC4K060-x, TCZR072, MCZR025-006, MCZR018-004, MCZR014-003, MC033X, MC12K200X-x, MC12K150X-x, MC12K100X-x, MC12K067X-x, RT series, MC4K050X-x, MC4K075X-x, MC4K100X-x, MC4K125X-x, MC4K150X-x				

- 1 At max Working Distance WD
- 2 At 25°C. At max pulse width (1 ms), max pulse frequency = 15 Hz.
- 3 5 m cable with straight female connector included. Optional cable with right angled connector is also available and must be ordered separately (refer to our website for further info and ordering codes).
- 4 At 25°C.

#### Ordering information

It's easy to select the right illuminator for your application: our part numbers are coded as **LTLA xy-z**, where **x** defines the illuminator size (B = medium, C = large), **y** refers to the power intensity (1 = medium, 2 = high) and **z** refers to color (W = white, R = red, G = green). For instance LTLA B2-R is a diffusive strobed low angle ring light illuminator - medium size high power red.

# LTDMLA series

Diffusive strobed dome + low angle illumination systems

**NEW**



## KEY ADVANTAGES

### Two independent illumination units in one single solution

Dome unit for homogeneous illuminations and low angle unit for dark field lightning can be independently operated.

### Ultra-high power light output and strobe mode only operation

For the inspection of fast moving object and extended LED lifetime.

### Rugged industrial design with built-in industrial connector

For easy integration into any machine vision system.

### Wide selection

Available in two sizes and two power intensities.

### Compatible LTDV strobe controllers available

For easy and appropriate power, control and synchronization of the illuminator.

**LTDMLA series** are ultra-high power diffusive LED strobed integrated illumination systems comprising a dome and a low angle ring light illuminator.

This solution provides two different illumination types in a single, compact, easy-to-integrate system: the dome unit provides non-directional diffused light that can be used to homogeneously illuminate complex shapes with curved and shiny surfaces, effectively eliminating glares and shadows. The low angle ring light unit provides darkfield lightning that can be used to cast shadows, greatly emphasizing surface irregularities, scratches and other details.

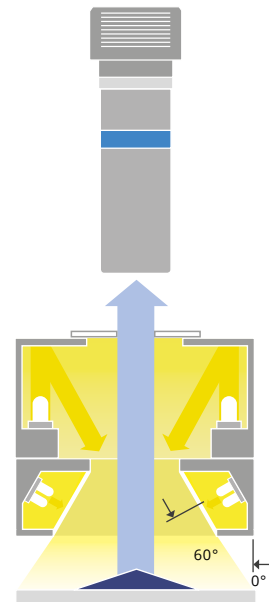
LTDMLA illuminators operate exclusively in strobe mode: the reduced heat generation guarantees extended LED lifetime and makes LTDMLA the perfect choice to illuminate very fast moving objects.

The two illumination units can be operated independently and easily powered, controlled and synchronized by compatible LTDV strobe controllers. LTDMLA series is available in:

- **two sizes:** medium and large, respectively with illumination area of 60 mm and 100 mm in diameter;
- **two power intensities:** medium power with driving current up to 7.5 A and high power with driving current up to 17 A.

LTDMLA series features industry standard connection (M12 four poles connector), resizable aperture for the dome unit that can be drilled to increase the diameter and accommodate the optics field of view and effective diffuser for the ring light unit to avoid hot spots formation. Additionally LTDMLA series can be easily mounted and integrated into any machine vision system by means of M6 screws.

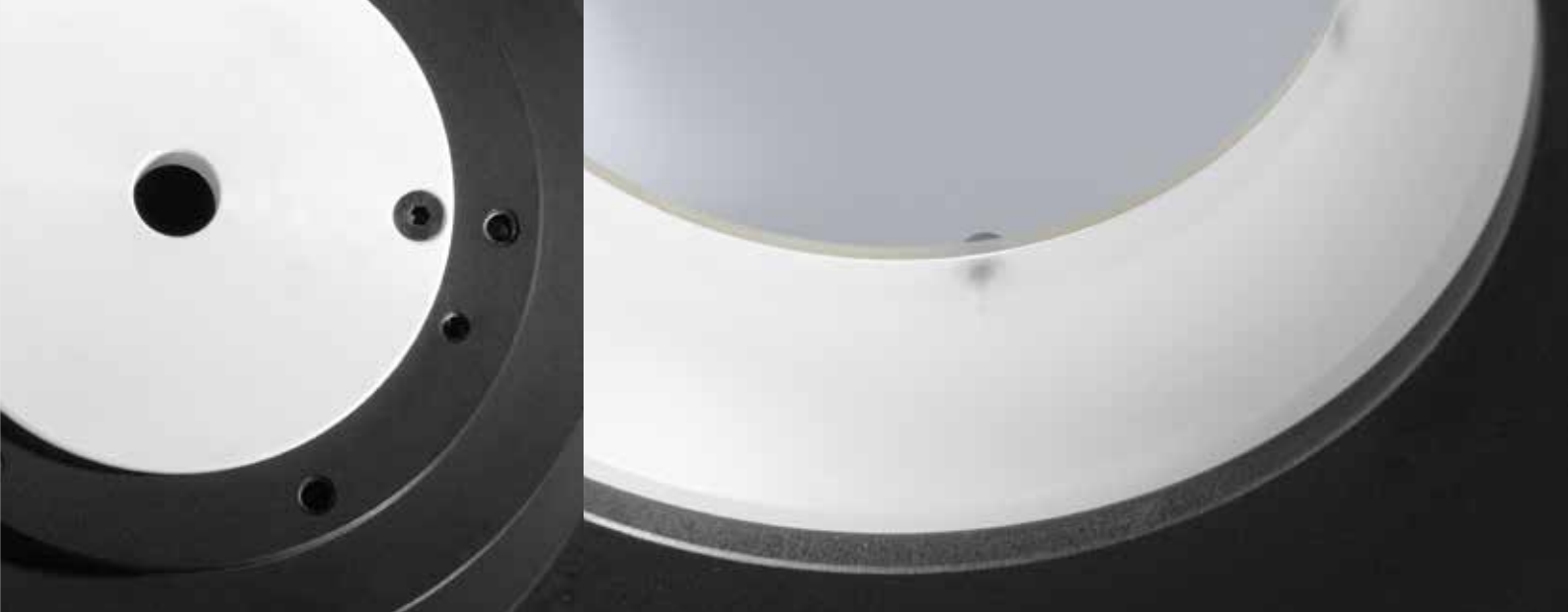
## Lighting structure



DESIGNED FOR OEM APPLICATIONS

Compatible LTDV strobe controllers available to easily power, control and synchronize LT illuminators.





Part number			LTDMLAB2-WW	LTDMLAC1-WW	LTDMLAC2-WW
<b>Optical specifications</b>					
<b>Dome unit</b>					
Number of LEDs			40	40	80
Light colour			white, 6500K	white	white, 6500K
Spectral FWHM		(nm)	n.a.	n.a.	n.a.
Illumination area diameter		(mm)	60	100	100
Suggested working distance WD		(mm)	5 - 50	5 - 50	5 - 50
Min estimated illumination <sup>1</sup>	At driving current = 3.5 A	(klux)	50	15	35
	At driving current = 7.5 A	(klux)	90	30	65
	At driving current = 17.0 A	(klux)	160	50	100
Aperture range		(mm)	10 - 50	10 - 60	10 - 60
<b>Low angle ringlight unit</b>					
Number of LEDs			40	40	80
Light colour			white, 6000K	white, 6500K	white, 6500K
Spectral FWHM		(nm)	n.a.	n.a.	n.a.
Diffusive ring			yes	yes	yes
Illumination area diameter		(mm)	60	100	100
Suggested working distance WD		(mm)	5 - 50	5 - 50	5 - 50
Min estimated illumination <sup>1</sup>	At driving current = 3.5 A	(klux)	55	35	70
	At driving current = 7.5 A	(klux)	105	70	140
	At driving current = 17.0 A	(klux)	210	125	250
<b>Electrical specifications</b>					
Power supply mode			strobe only, constant current driving	strobe only, constant current driving	
Driving current	Min	(A)	3.5	3.5	3.5
	Max	(A)	17.0	7.5	17.0
Pulse width <sup>2</sup>		(ms)	≤ 1	≤ 1	≤ 1
Connection Type <sup>3</sup>			M12 industrial male connector	M12 industrial male connector	
Estimated MTBF <sup>4</sup>		(hours)	> 50000	> 50000	> 50000
<b>Mechanical specifications</b>					
Dimensions	Length	(mm)	166.5	206	206
	Width	(mm)	133	206	206
	Height	(mm)	104	147	147
Materials			black anodized aluminum body	black anodized aluminum body / Painted steel reflector	
Clamping system			4 holes for M6 screw	8 threaded holes for M6 screw	
<b>Compatibility</b>					
Strobe controllers			LTDV1CH-17 (2 units), LTDV6CH	LTDV1CH-7 (2 units), LTDV6CH	LTDV1CH-17 (2 units), LTDV6CH
Lenses			TCLWD series, RT series	RT series, MC4K050X	

<sup>1</sup> At max Working Distance WD

<sup>2</sup> At 25°C. At max pulse width (1 ms), max pulse frequency = 15 Hz.

<sup>3</sup> PIN 1 and PIN 2 for the dome unit, PIN 3 and PIN 4 for the ringlight unit.

5 m cable with straight female connector included. Optional cable with right angled connector is also available and must be ordered separately (refer to our website for further info and ordering codes).

<sup>4</sup> At 25 °C.

#### Ordering information

It's easy to select the right illuminator for your application: our part numbers are coded as **LTDMLA xy-WW** where **x** defines the illuminator size (B = medium, C = large), **y** refers to the power intensity (1 = medium, 2 = high). For instance LTDMLA B2-WW is a diffusive strobed dome + low angle illumination system - medium size, high power, dome white, ringlight white.

# View-through system

Space saving illumination system for double-side object inspection

**NEW**



### KEY ADVANTAGES

#### Compact space-saving solution for inspection of fast moving object

Illuminates two sides of an object almost simultaneously.

#### Ultra-high power light output and strobe mode only operation

For the inspection of fast moving object and extended LED lifetime.

#### Rugged industrial design with built-in industrial connector

For easy integration with any machine vision system.

#### Modular configuration.

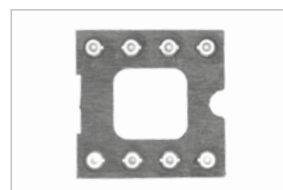
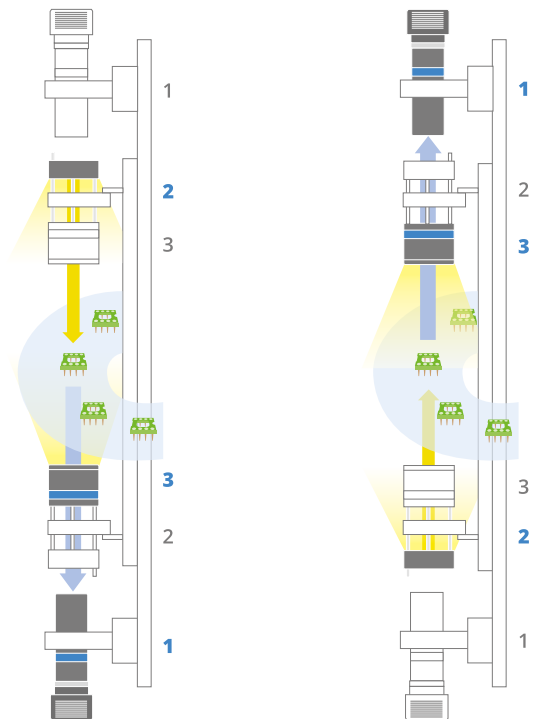
**View-through system** is a compact space-saving unique illumination solution designed to illuminate two sides of an object. It consists of two symmetrical modules, each one made of two illumination units:

- A diffusive strobed dome illuminator (white color)
- A special active “view-through” backlight unit (white color)

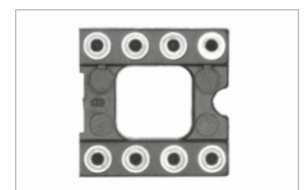
View-through system is designed to create very compact inline inspection solutions that illuminate and image both sides of fast-moving objects. While one camera acquires the image of one side of an object, the corresponding dome and special backlight units emit light simultaneously so that one side of the object can be inspected. Subsequently the dome and the backlight units are turned off so that the second camera can acquire the image of the other side of the object while its corresponding dome and special backlight units are now switched on.

Such innovative and unique approach can be achieved thanks to the special backlight units which act either as transparent windows (when turned off) or as backlights (when turned on) and enables to quickly and accurately inspect fast-moving objects almost simultaneously, in a very compact solution. View-through system can be used for many different inspections, especially for identification of surface defects/features with applications spanning from automotive to pharmaceutical. View-through system is available as LTVTA1-W, which consists of two dome units and two active backlight “view-through” units (white color) or as LTVT BENCH, a complete bench solution which additionally includes a base plate with two right-angle brackets, the LTDV6CH compatible strobe controller (programmable) and the ADPT001 RS485-USB adapter.

### Lighting structure



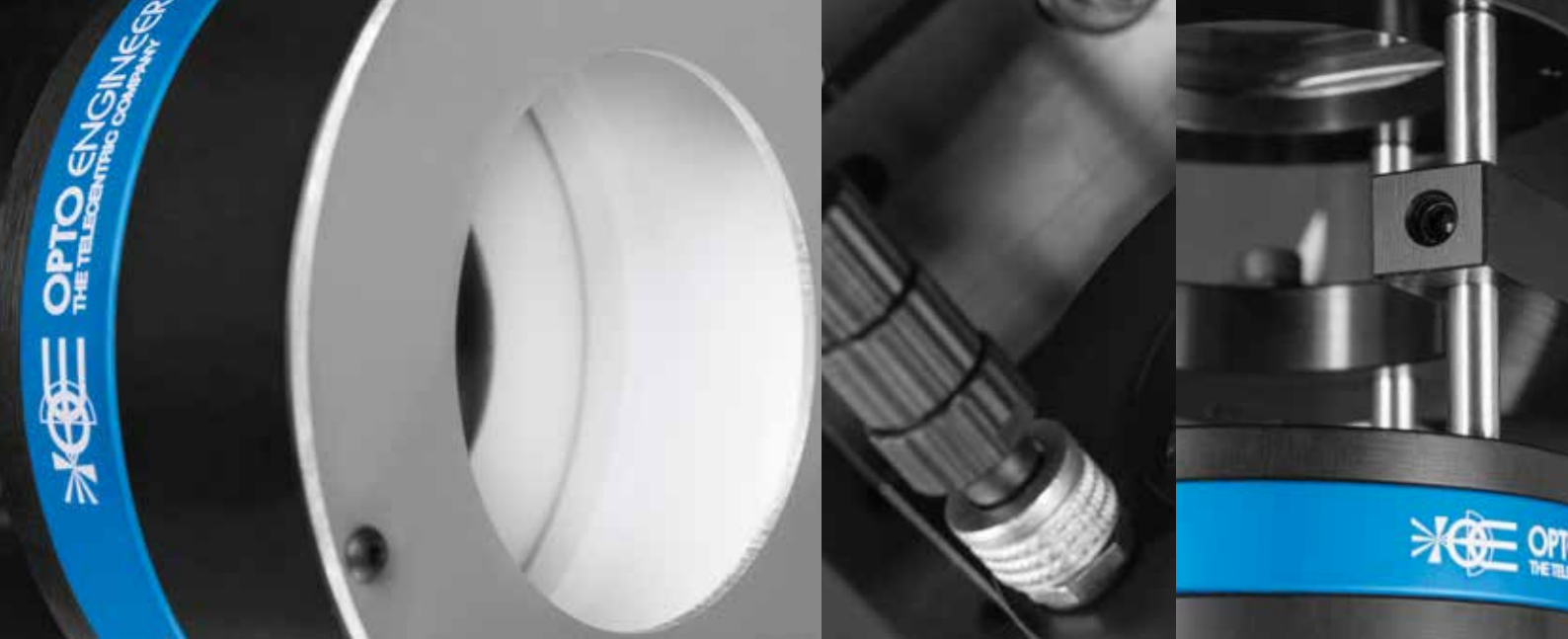
DIL socket, bottom side



DIL socket, top side

### DESIGNED FOR OEM APPLICATIONS

Compatible LTDV6CH strobe controllers available to easily power, control and synchronize the View-through system.



Part number			LTVTA1-W	LTVTBENCH
<b>Optical specifications</b>				
<b>Dome unit</b>				
Number of LEDs				15
Light colour				white, 6000K
Spectral FWHM		(nm)		n.a.
Illumination area diameter		(mm)		40
Suggested working distance WD		(mm)		5 - 25
Min estimated illumination <sup>1</sup>	At driving current = 3.5 A	(klux)		290
	At driving current = 7.5 A	(klux)		490
Aperture range		(mm)		48 (fixed)
<b>Active backlight view-through unit</b>				
Number of LEDs				18
Light colour				white, 6000K
Spectral FWHM		(nm)		n.a.
Diffusive material				yes
Illumination area diameter		(mm)		40
Suggested working distance WD		(mm)		n.a.
Min estimated illumination <sup>1</sup>	At driving current = 17.0 A	(klux)		5
<b>Electrical specifications</b>				
Power supply mode				strobe only, constant current driving
Pulse width <sup>2</sup>		(ms)		≤ 1
Connection Type <sup>3</sup>				M8 industrial male connector
<b>Dome unit</b>				
Driving current	Min - Max	(A)		3.5 - 7.5
<b>Active backlight view-through unit</b>				
Driving current	Min - Max	(A)		3.5 - 17.0
Estimated MTBF <sup>4</sup>		(hours)		> 50000
<b>Mechanical specifications</b>				
Dimensions	Length	(mm)	107	600
	Width	(mm)	84	100
	Height	(mm)	125	155.5
Materials			black anodized aluminum body	
Clamping system			4 threaded holes for M6 screw	
<b>Compatibility</b>				
Lenses			TCLWD series, RT series	

Items included	LTVTA1-W		LTVTBENCH	
	Description	Qty	Description	Qty
	Dome unit <sup>5</sup>	2	Dome unit <sup>5</sup>	2
	Active backlight view-through unit <sup>5</sup>	2	Active backlight view-through unit <sup>5</sup>	2
			Base plate with two right-angle brackets	1
			LTDV6CH strobe controller	1
			ADPT001 adapter RS485-USB	1

<sup>1</sup> At max Working Distance WD.

<sup>2</sup> At 25°C. At max pulse width (1 ms), max pulse frequency = 15 Hz.

<sup>3</sup> PIN 1 and PIN 2 for the dome unit, PIN 3 and PIN 4 for the ringlight unit.

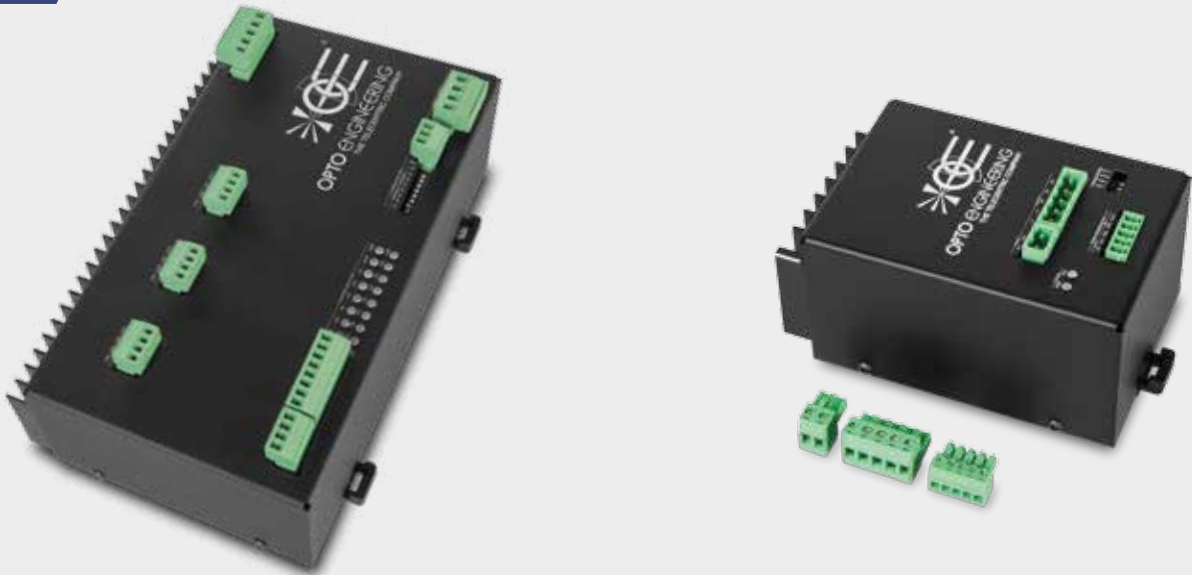
<sup>4</sup> At 25 °C.

<sup>5</sup> Cables included.

# LTDV series

Strobe controllers

**NEW**



**LTDV series** are accurate strobe controller units designed to easily power and control IL illuminators, including LTDM, LTLA, LTDMLA series and View-through system. To get the very best out of Opto Engineering LED lighting solutions, in terms of both brightness stability and control, lights should be driven from a current source, not from a constant voltage supply. This is because small variations in temperature or voltage can cause a large change in brightness in LEDs.

The brightness is approximately linear with current, so by driving the lighting with a current, intensity control is linear.

LTDV series comprises LTDV6CH programmable strobe controller featuring six output channels and LTDV1CH-7 / LTDV1CH-17 units featuring one output channel.

Additionally LTDV6CH can be quickly configured using an easy-to-use configuration software which can be downloaded from our website.

#### KEY ADVANTAGES

**Compatible with** most Opto Engineering LT LED lighting solutions.

**6 output channels** or **1 output channel**.

**Max output current up to 17.0 A.**

#### Original design

Small, compact unit with DIN rail mounting.

#### DESIGNED FOR OEM APPLICATIONS

Designed to power control LTDM, LTLA, LTDMLA series and View-through systems.  
LTDV6CH includes software for easy configuration.



Part number			LTDV6CH	LTDV1CH-7	LTDV1CH-17
<b>Electrical specifications</b>					
User interface			RS485 <sup>1</sup>	4-way DIP switch	4-way DIP switch
Output channels n°			6 independent constant current outputs	1 constant current output	1 constant current output
Output current range <sup>2</sup>	(A)		3.5A - 17.0	7.5 (fixed)	17.0 (fixed)
Max dissipable thermal power per channel	(W)		5	8	8
Synchronization inputs n°			4 opto-isolated digital inputs <sup>3</sup>	1 opto-isolated digital input	1 opto-isolated digital input
Synchronization outputs n°			2 opto-isolated digital outputs	1 opto-isolated digital output	1 opto-isolated digital output
Pulse delay	(µs)		0 - 65535 <sup>4</sup>	n.a.	n.a.
Pulse width	(µs)		10 - 65535 <sup>4</sup>	n.a.	n.a.
Timing repeatability	for pulse delay	(µs)	0.1	n.a.	n.a.
	for pulse width	(µs)	0.5	n.a.	n.a.
Supply voltage	(V, DC)		24 <sup>5</sup>	24 - 48	
Output voltage	(V)		0 - 36	0 - 12 (with 24V supply) or 0 - 36 (with 48V supply)	
Max startup/inrush current	(A)		2.5	2.5	2.5
<b>Mechanical specifications</b>					
Dimensions <sup>6</sup>	length	(mm)	205	70	70
	height	(mm)	84	82	82
	width	(mm)	123	119	119
Mounting				DIN rail	
Accessories			ADPT001 <sup>7</sup>	n.a.	n.a.
Compatible products			LTDM series, LTLA series, LTDMLA series, View-through system	LTDMA1-W, LTDMA1-G, LTDMA1-R, LTDMC1-W, LTLAC1-W, LTDMLAC1-WW <sup>8</sup>	LTDMB2-W, LTDMB2-G, LTDMB2-R, LTDMC2-W, LTDMC2-G, LTDMC2-R, LTLAB2-W, LTLAB2-G, LTLAB2-R, LTLAC2-W, LTLAC2-G, LTLAC2-R, LTDMLAB2-WW, LTDMLAC2-WW <sup>8</sup>

<sup>1</sup> With Modbus RTU slave protocol.  
<sup>2</sup> In steps of 98 mA.  
<sup>3</sup> Opto Isolated. Operate from 3V to 24V.  
<sup>4</sup> In steps of 1 µs.  
<sup>5</sup> Regulated ± 10%.  
<sup>6</sup> Including DIN fixing.

<sup>7</sup> To be ordered separately. ADPT001 consists of - one RS485-USB adapter and - one cable with 3 elements for connection with LTDV6CH. In order to configure LTDV6CH via software ADPT001 must be used. Refer to our website for further info.  
<sup>8</sup> LTDMLA series require two LTDV1CH strobe controllers to power and control both the two integrated illumination units (dome + ring light).

# Accessories to make the most of Opto Engineering products.

No product is an island.

We are fully aware that Opto Engineering products live in complex ecosystems where optics must be mechanically supported, calibrated and serviced:

**we strive to provide complete solutions for easy deployment of our optical products,**

ranging from clamping supports to filters, patterns, and a useful selection of general-purpose machine vision optics.

Of course, optical and electrical replacement parts are provided, as well as the online documentation needed for the most common service tasks.



Refer to specific datasheets available at [www.opto-engineering.com](http://www.opto-engineering.com) for product compliancy with regulations, certifications and safety labels.





Accessories

# CMBS series

45° beam splitter

**NEW**



## KEY ADVANTAGES

**Ready to use** and easy to setup.

Ideal to create **coaxial illumination solutions**.

**50% transmission and 50% reflection.**

**Easy and secure clamping system.**

**Compatible** with telecentric lenses and illuminators.

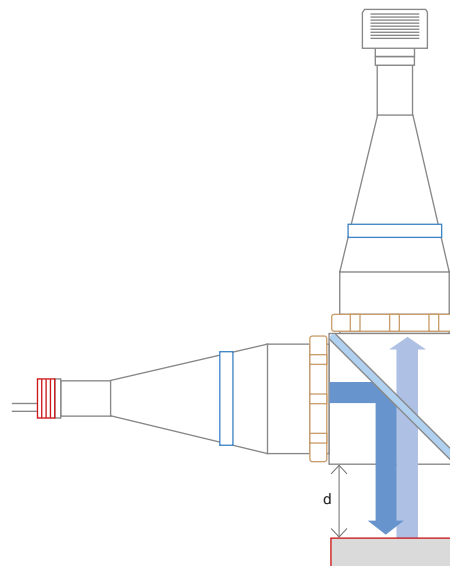
**CMBS series** is a collection of **45° plate beam splitters** designed to easily create coaxial illumination solutions with Opto Engineering telecentric lenses and collimated illuminators. Using these 45° plate beam splitters, an incoming light beam can be divided into two separate beams with a 50% reflection / 50% transmission ratio.

CMBS series is designed for 45° angle of incidence in the 430 - 670 nm waveband: one surface is beam-splitter coated while the second one features an anti-reflective coating.

CMBS series enhances Opto Engineering telecentric lenses and collimated illuminators to create the perfect coaxial illumination setup: simply position the telecentric lens and the collimated illuminator in the appropriate port.

Each of the two ports feature a tightening knob that allows for easy and secure clamping. In addition, compatible protective windows are available.

Coaxial illumination is especially used to illuminate plain reflective objects and effectively highlight flaws or dents (which appear in the image as dark features). Whenever you are looking for a precise and easy way to setup a coaxial illumination solution, CMBS series is the ideal choice.



CMBS object distances (d) in mm

Compatible products	TC series						TCLWD series	TC2MHR-4MHR series					TC16M series				TC12K series		
	036	048	056	064	072	080	xxx	036	048	056	064	080	036	048	056	064	080	064	080
CMBS 016							82.8												
CMBS 036	20.1							20.1					19.6						
CMBS 048		37.0							37.0					29.4					
CMBS 056			50.7							50.7					41.4				
CMBS 064				63.8							63.8					52.5		44.3	
CMBS 080					90.1	90.1						90.1					60.4		19.8





## Product combinations examples



TC23 036 + CMBS 036 + LTCLHP 036-G



TC2MHR 036-F + CMBS 036 + LTCLHP 036-G



TCLWD 066 + CMBS 016 + LTCLHP 016-G

### SETUP

Refer to the mechanical layouts available online to check compatibility with CMHO and other mount systems.

Part number	Optical specifications			Mechanical specifications					Compatible products	
	Coating (front)	Coating (back)	Deviation angle (deg)	Clamping diameter (mm)	Clamping system	Length (mm)	Width (mm)	Height (mm)	Telecentric lenses	Telecentric illuminators
	1	2								
CMBS 016	VIS Coating: Beam splitter 50/50 @ 45°	AR Vis Coating: normal reflectance <0.5% bandwidth	90	37.7	lockring	85.8	85.8	64	TCLWD series	LTCLHP016-x
CMBS 036	VIS Coating: Beam splitter 50/50 @ 45°	AR Vis Coating: normal reflectance <0.5% bandwidth	90	61	lockring	104.4	104.4	88	TCxx036, TC2MHR036-x, TC4MHR036-x, TC16M036-x	LTCLHP036-x
CMBS 048	VIS Coating: Beam splitter 50/50 @ 45°	AR Vis Coating: normal reflectance <0.5% bandwidth	90	75	lockring	119	119	102	TCxx048, TC2MHR048-x, TC4MHR048-x, TC16M048-x	LTCLHP048-x
CMBS 056	VIS Coating: Beam splitter 50/50 @ 45°	AR Vis Coating: normal reflectance <0.5% bandwidth	90	80	lockring	129.3	129.3	108	TCxx056, TC2MHR056-x, TC4MHR056-x, TC16M056-x	LTCLHP056-x
CMBS 064	VIS Coating: Beam splitter 50/50 @ 45°	AR Vis Coating: normal reflectance <0.5% bandwidth	90	100	lockring	139.2	139.2	128	TCxx064, TC2MHR064-x, TC4MHR064-x, TC16M064-x, TC12K064	LTCLHP064-x
CMBS 080	VIS Coating: Beam splitter 50/50 @ 45°	AR Vis Coating: normal reflectance <0.5% bandwidth	90	116	lockring	158.9	158.9	144	TC23072, TCxx080, TC2MHR080-x, TC4MHR080-x, TC16M08-x, TC12K080	LTCLHP080-x

1 Tolerance +/- 5%

2 Bandwidth: 430-670 nm.

# CMMR series

45° first surface mirrors

**NEW**



**KEY ADVANTAGES**

**Reflect light at 90°.**

Ideal for **limited spaces.**

**Easy and secure clamping system.**

**Compatible** with telecentric lenses and illuminators.

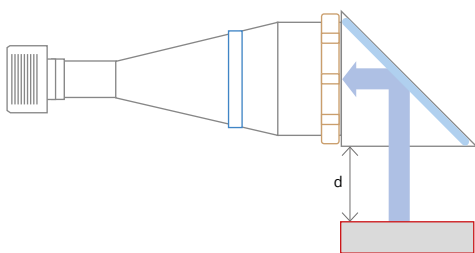
Optional **protective windows** available.

Production environments often present size constraints, limiting the choice of optics and sometimes sacrificing optical performance for size compatibility. **CMMR series** is the Opto Engineering answer, producing a 90° bend in the light path and opening new installation options for your application.

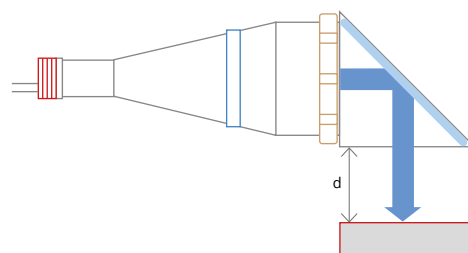
CMMR series is a family of first surface mirrors designed for our telecentric lenses and illuminators which enables viewing at 90° to the optical axis of your telecentric lens and camera.

These right-angle mirrors can also be used together with collimated illuminators, reflecting incident rays coming from the light source at 90° angle.

CMMR series feature a precise tightening knob that allows for easy and secure clamping. In addition, compatible protective windows are available. Whenever overall system dimension and precision alignment are critical factors for your application, CMMR series is the ideal choice.



CMMR first surface mirror combined with a telecentric lens.



CMMR first surface mirror combined with a telecentric illuminator.

**CMMR object distances (d) in mm\***

Compatible products	TC series									TC2MHR-4MHR series					TC16M series					TC12K series				
	036	048	056	064	072	080	085	13096	xx96	036	048	056	064	080	096	036	048	056	064	080	096	064	080	
CMMR 036	20.1									20.1						19.6								
CMMR 048		37.0									37.0						29.4							
CMMR 056			50.7									50.7						41.4						
CMMR 064				63.8									63.8						52.5				44.3	
CMMR 080					90.1	90.1								90.1						60.4				19.8
CMMR 096							124.0	124.0	123.0						123.0						106.4			

(\*): When placing W10xx protective windows in front of CMMR 45° mirrors, working distance increases of approximately one third of the window thickness (t)  
 $WD_{new} \approx WD_{lens} + t/3$

## SETUP

Refer to the mechanical layouts available online to check compatibility with CMHO and other mount systems.

### Application example



LTCLHP080-x + CMMR080 and TC23080 + CMMR080 imaging a screw in a collimated setup.

### Product combinations examples



CMMR 080 combined with TC23 080



CMMR 056 combined with LTCLHP 056-G

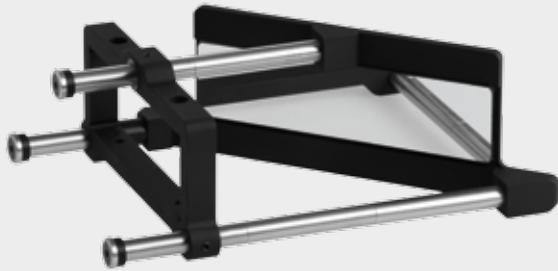
Part number	Optical specifications		Mechanical specifications					Compatible products		Optional accessories	
	Coating	Deviation angle (deg)	Clamping diameter (mm)	Clamping system	Length (mm)	Width (mm)	Height (mm)	Weight (g)	Telecentric lenses	Telecentric illuminators	Protective windows
<b>CMMR 036</b>	Aluminum reflective coating	90	61	locking	88.0	88.0	107.2	595	TCxx036, TC2MHR036-x, TC4MHR036-x, TC16M036-x	LTCLHP036-x	WI 036
<b>CMMR 048</b>	Aluminum reflective coating	90	75	locking	102.0	102.0	121.1	508	TCxx048, TC2MHR048-x, TC4MHR048-x, TC16M048-x	LTCLHP048-x	WI 048
<b>CMMR 056</b>	Aluminum reflective coating	90	80	locking	108.0	108.0	131.3	586	TCxx056, TC2MHR056-x, TC4MHR056-x, TC16M056-x	LTCLHP056-x	WI 056
<b>CMMR 064</b>	Aluminum reflective coating	90	100	locking	128.0	128.0	141.3	779	TCxx064, TC2MHR064-x, TC4MHR064-x, TC16M064-x, TC12K064	LTCLHP064-x	WI 064
<b>CMMR 080</b>	Aluminum reflective coating	90	116	locking	144.0	144.0	160.9	1605	TC23072, TCxx080, TC2MHR080-x, TC4MHR080-x, TC16M080-x, TC12K080	LTCLHP080-x	WI 080

**1** Normal reflectance > 98% - bandwidth: 430-670 nm.

**2** To be ordered separately.

# CMMR series

## CMMR4K models



CMMR4K-L



CMMR4K-V

**CMMR4K** are 45° first surface mirrors that produce a right angle bend in the light path.

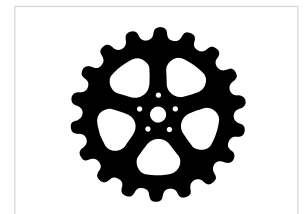
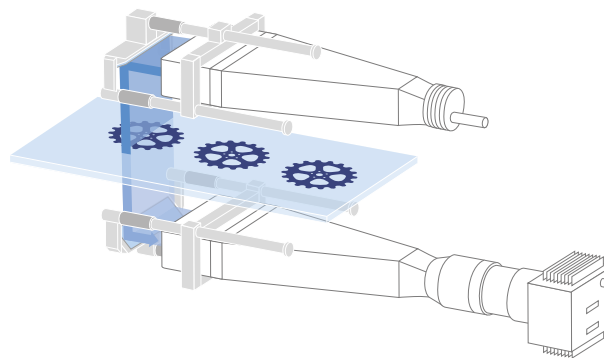
CMMR4K are available in two versions: -V and -L, respectively bending the light rays vertically (either upwards or downwards) or laterally (either to the left or the right).

Additionally, length of CMMR4K mirrors can be varied to precisely adjust the distance of the mirror from the front lens of TC4K/LTCL4K. Refer to the schematics for further details.

### COMPATIBILITY

CMMR4K are specifically designed to be interfaced with TC4K and LTCL4K series.

### Application examples



A LTCL4K illuminator coupled to a TC4K lens with CMMR4K deflecting mirrors to scan samples on a glass surface.

Part number	Optical specifications		Clamping system	Mechanical specifications				Compatible products	
	Coating	Deviation angle (deg)		Length (mm)	Width (mm)	Height (mm)	Weight (g)	Telecentric lenses	Telecentric illuminators
<b>1</b>	<b>2</b>								
<b>CMMR4K 060-V</b>	Aluminum reflective coating	90	mounting screws	199.0	116.0	72.0	556	TC4K060-x	LTCL4K060-x
<b>CMMR4K 060-L</b>	Aluminum reflective coating	90	mounting screws	208.2	118.4	72.0	504	TC4K060-x	LTCL4K060-x
<b>CMMR4K 090-V</b>	Aluminum reflective coating	90	mounting screws	206.0	147.0	72.0	615	TC4K090-x	LTCL4K090-x
<b>CMMR4K 090-L</b>	Aluminum reflective coating	90	mounting screws	214.0	150.3	72.0	553	TC4K090-x	LTCL4K090-x
<b>CMMR4K 120-V</b>	Aluminum reflective coating	90	mounting screws	199.0	177.0	72.0	783	TC4K120-x	LTCL4K120-x
<b>CMMR4K 120-L</b>	Aluminum reflective coating	90	mounting screws	241.7	187.6	72.0	645	TC4K120-x	LTCL4K120-x
<b>CMMR4K 180-V</b>	Aluminum reflective coating	90	mounting screws	267.0	241.0	72.0	866	TC4K180-x	LTCL4K180-x
<b>CMMR4K 180-L</b>	Aluminum reflective coating	90	mounting screws	326.7	253.6	72.0	885	TC4K180-x	LTCL4K180-x

**1** -V stands for Vertical bend, -L stands for Lateral bend. See drawings for details about deviation axis orientation.

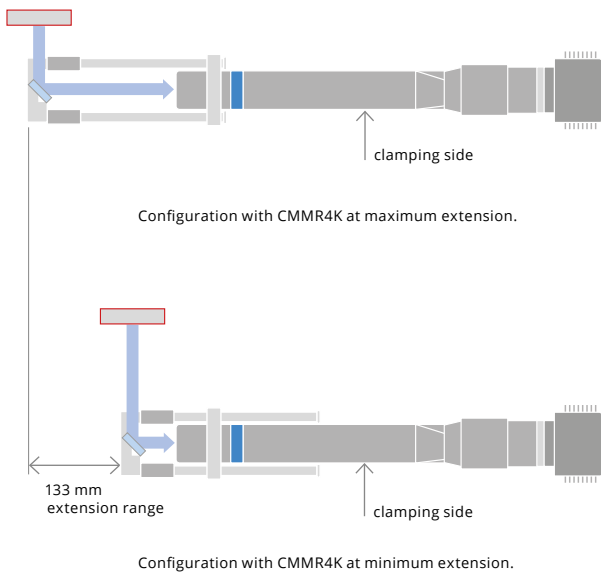
**2** Normal reflectance > 98% - bandwidth: 430-670 nm.



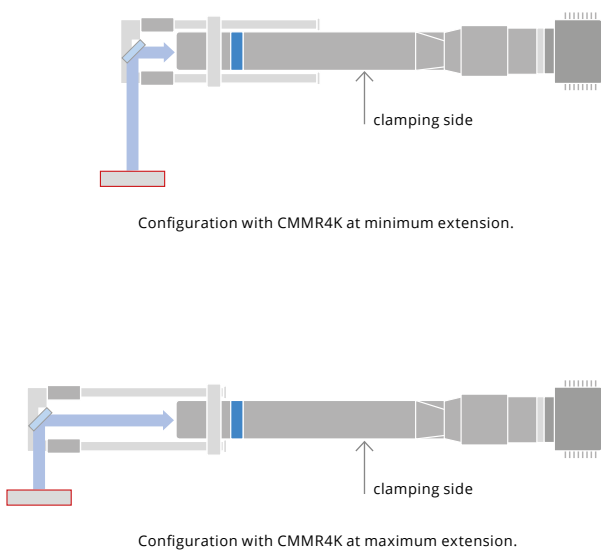
### CMMR4K-V schematics

CMMR4K-V bends the light rays vertically.

#### UPWARD BEND



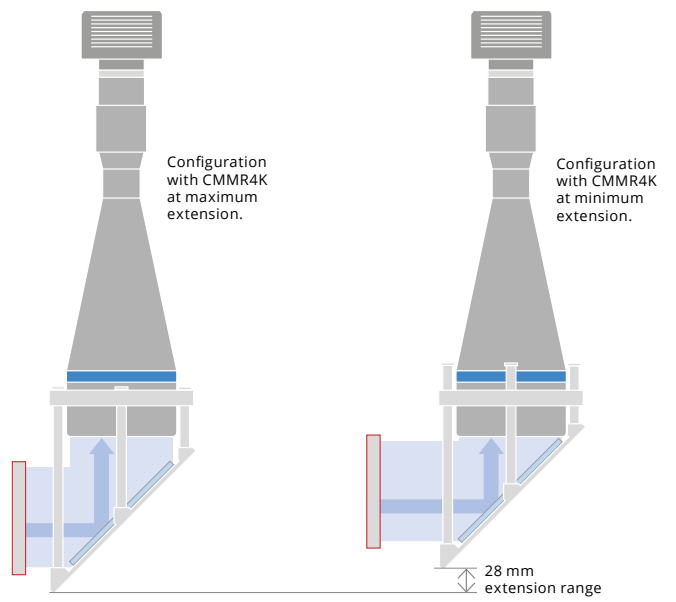
#### DOWNWARD BEND



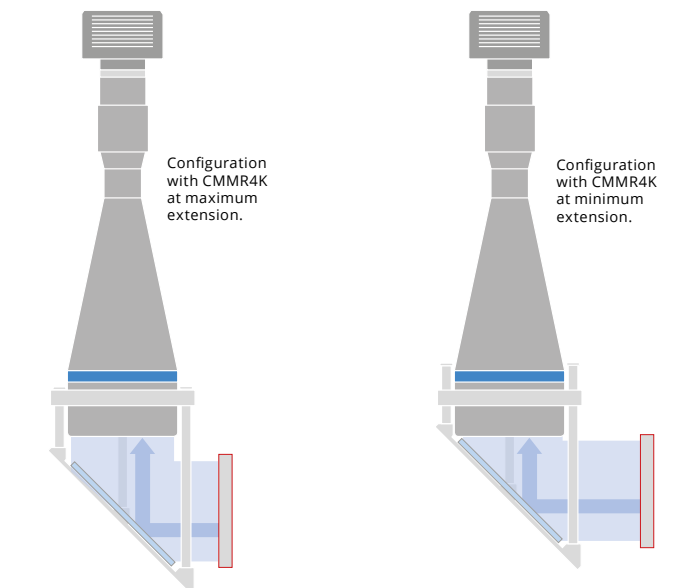
### CMMR4K-L schematics

CMMR4K-L bends the light rays laterally.

#### LEFT BEND



#### RIGHT BEND



# WI series

Protective windows

**NEW**



#### KEY ADVANTAGES

**Protection from dust / debris** or other hazardous particles.

**No change in optical magnification.**

**Compatible with** telecentric lenses, LTCLHP illuminators and CMMR mirrors.

**WI series** is a range of optical windows designed to protect telecentric lenses and collimated illuminators.

Material spatter and other hazards such as dust or debris might in fact damage the lens or result in optical performance degradation.

These plano-plano windows effectively shield telecentric lenses from the outside environment without affecting the quality of your imaging system because they do not cause changes in optical magnification.

WI series is also compatible with CMMR mirrors, preserving their delicate optical surfaces from dust or other hazardous particles.

Each window is complemented by its own CMWF holder which features a precise tightening knob that allows for easy and secure clamping. CMWF holders are required to mount WI protective windows in front of telecentric lenses and must be ordered separately.

#### Product combinations examples



WI080 + CMWF080 + TC23080



WI056 + CMWF056 + LTCLHP056-G



WI windows	Optical specifications	Mechanical specifications			Compatible products		
Part number	Transmittance band (nm)	Substrate	Diameter (mm)	Thickness	Telecentric lenses (mm)	Telecentric illuminators	CMMR
					<b>1</b>	<b>1</b>	
WI 036	450-710	N-BK7	61	3	TCxx036, TC2MHR036-x, TC4MHR036-x, TC16M036-x	LTCLHP036-x	CMMR036
WI 048	450-710	N-BK7	75	3	TCxx048, TC2MHR048-x, TC4MHR048-x, TC16M048-x	LTCLHP048-x	CMMR048
WI 056	450-710	N-BK7	80	3	TCxx056, TC2MHR056-x, TC4MHR056-x, TC16M056-x	LTCLHP056-x	CMMR056
WI 064	450-710	N-BK7	100	3	TCxx064, TC2MHR064-x; TC4MHR064-x, TC16M064-x	LTCLHP064-x	CMMR064
WI 080	450-710	N-BK7	116	3	TC23072, TCxx080; TC2MHR080-x, TC4MHR080-x, TC16M080-x	LTCLHP080-x	CMMR080
WI 096	450-710	N-BK7	143	3	TC23085, TCxx096, TC2MHR096-x, TC4MHR096-x, TC16M096-x	LTCLHP096-x	CMMR096

**1** CMWF0xx mounting mechanics required. When WI0xx is placed in front of a lens, its working distance increases of approximately  $\frac{1}{3}$  of the window thickness.

CMWF holders	Technical details	Optical spec	Mechanical specifications			Compatibility
Part number	Description	Active area diameter (mm)	Clamping diameter (mm)	Height (mm)	Weight (g)	WI series
CMWF036	Holder for WI series, clamping diameter = 61 mm	51	61	22	108	WI036
CMWF048	Holder for WI series, clamping diameter = 75 mm	65	75	27	132	WI048
CMWF056	Holder for WI series, clamping diameter = 80 mm	70	80	27	151	WI056
CMWF064	Holder for WI series, clamping diameter = 100 mm	90	100	27	181	WI064
CMWF080	Holder for WI series, clamping diameter = 116 mm	106	116	27	210	WI080
CMWF096	Holder for WI series, clamping diameter = 143 mm	133	143	27	258	WI096

#### Ordering information

When ordering, include the following two items:

- **WIxxx** protective window
- **CMWFxxx** holder

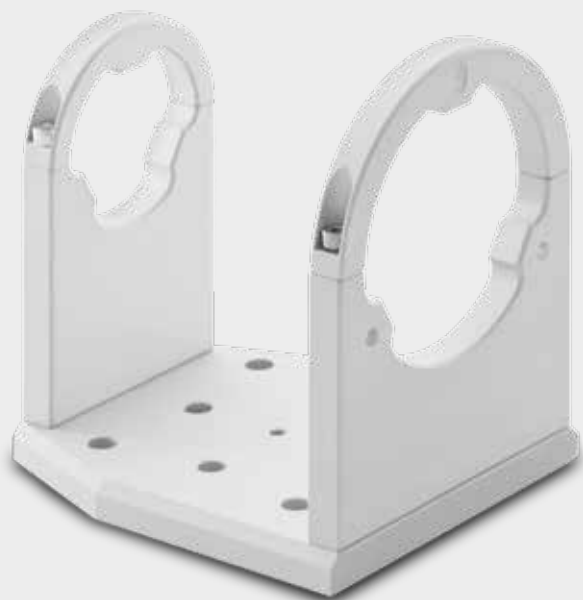
For example, if you need a protective window for a **TC 12036** telecentric lens, you have to order both the following items:

- **WI036** protective window
- **CMWF036** holder

The CMWF holder is not required when interfacing WI windows with CMMR.

# CMHO series

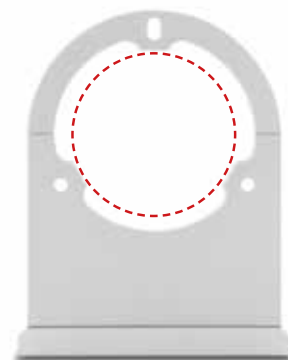
## Clamping mechanics



The accurate alignment of optical components is crucial when designing measurement systems. Besides optical components stability, the mechanical system layout should assure that the optical axis is orthonormal to the measurement plane.

For this purpose Opto Engineering supplies **CMHO series** clamping mechanics, compatible with our lenses and telecentric illuminators.

Three-point mounting grants a very precise and stable alignment of the optical components, also making the assembling procedure quick and simple.



### Assembling a TC lens on a CMHO clamping support







Part number	Compatibility		Mechanical specifications			
	Opto Engineering optics	CMPT plates	Length (mm)	Width (mm)	Height (mm)	Optical axis height (mm)
<b>CMHO 023</b>	TC2300y, TC23012, TC4M00y-x, LTCLHP023-x	004-009	20.0	53.0	66.5	40.0
<b>CMHO 016</b>	TCxx016, TCxMHR016-x, LTCLHP016-x, TCLWD series	016-024	20.0	62.5	71.2	40.0
<b>CMHO 024</b>	TCxx024, TCxMHR024-x, LTCLHP024-x	016-024	20.0	62.5	71.2	40.0
<b>CMHO 036</b>	TCxx036, TCxMHR036-x, TC16M036-x, LTCLHP036-x	036	110.0	97.0	125.5	80.0
<b>CMHO 048</b>	TCxx048, TCxMHR048-x, TC16M048-x, LTCLHP048-x	048	140.0	111.0	132.5	80.0
<b>CMHO 056</b>	TCxx056, TCxMHR056-x, TC16M056-x, LTCLHP056-x	056	162.0	116.0	135.0	80.0
<b>CMHO 064</b>	TCxx064, TCxMHR064-x, TC16M064-x, LTCLHP064-x	064	175.0	137.0	145.0	80.0
<b>CMHO 080</b>	TC23072, TCxx080, TCxMHR080-x, TC16M080-x, LTCLHP080-x, PCxx030XS	080	230.0	153.0	152.0	80.0
<b>CMHO 096</b>	TC23085, TCxx096, TCxMHR096-x, TC16M096-x, LTCLHP096-x	096	265.0	179.0	186.5	100.0
<b>CMHO 120</b>	TC23110, TCxx120, TCxMHR120-x, TC16M120-x, LTCLHP120-x	-	204.0	220.0	240.0	130.0
<b>CMHO 144</b>	TC23130, TCxx144, TCxMHR144-x, TC16M144-x, LTCLHP144-x	-	204.0	232.0	247.0	130.0
	<b>TC12K</b>					
<b>CMHO TC12K 064</b>	TC12K064	-	486.0	152.0	150.0	85.0
<b>CMHO TC12K 080</b>	TC12K080	-	486.0	152.0	158.0	85.0
	<b>TC16M</b>					
<b>CMHO TC16M 009</b>	TC16M009-x	-	143.0	66.5	81.3	50.0
<b>CMHO TC16M 012</b>	TC16M012-x	-	143.0	66.5	81.3	50.0
<b>CMHO TC16M 018</b>	TC16M018-x	-	143.0	66.5	81.3	50.0
	<b>MC12K</b>					
<b>CMHO MC12K 025</b>	MC12K008-025	-	140.0	111.0	132.5	80.0
<b>CMHO MC12K 067</b>	MC12K050-067	-	140.0	111.0	132.5	80.0
<b>CMHO MC12K 200</b>	MC12K100-200	-	140.0	111.0	132.5	80.0
	<b>TCZR</b>					
<b>CMHO TCZR</b>	TCZR036, TCZR072	-	138.0	93.6	113.3	66.5
	<b>PCCD</b>					
<b>CMHO PCCD</b>	PCCDxxx	-	139.0	76.0	20.0	92.0

# CMPT series

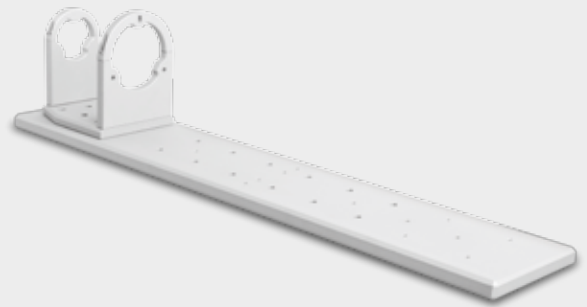
## Mounting plates



**CMPT plates** are mechanical components designed to build up optical benches for measurement applications. Most Opto Engineering telecentric lenses and illuminators can be mounted on these plates using CMHO clamping mechanics.

For very accurate measurement applications, calibration patterns can be precisely positioned in front of the lens with the CMPH pattern holders, enabling a perfect calibration of the optical system.

Part number	Compatibility		Mechanical specifications			
	Clamping mechanics	Pattern holders	Length	Width	Thickness	Weight
	CMHO	CMPH				
(mm)	(mm)	(mm)	(g)			
<b>CMPT 004-009</b>	023	004-024	199.6	56.0	10.0	286
<b>CMPT 016-024</b>	016, 024	004-024	226.8	66.5	10.0	385
<b>CMPT 036</b>	036	036-056	477.0	103.0	15.0	1950
<b>CMPT 048</b>	048	036-056	596.0	117.0	15.0	2770
<b>CMPT 056</b>	056	036-056	631.0	122.0	15.0	3060
<b>CMPT 064</b>	064	064-096	783.0	143.0	15.0	4460
<b>CMPT 080</b>	080	064-096	868.0	158.0	15.0	5470
<b>CMPT 096</b>	096	064-096	1005.0	185.0	20.0	9940



# CMPH series

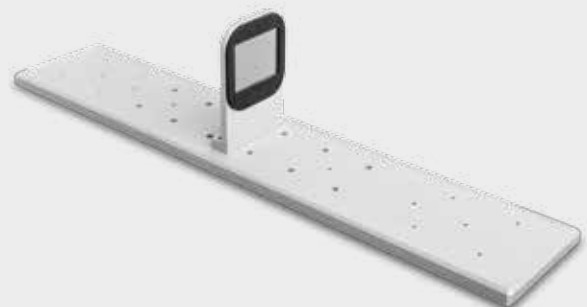
## Pattern holders



Software calibration is accurate if **pattern placement** is accurate too. To do so, Opto Engineering offers **specific CMPH pattern holders** to easily and precisely mount each calibration pattern on its holding mechanics.

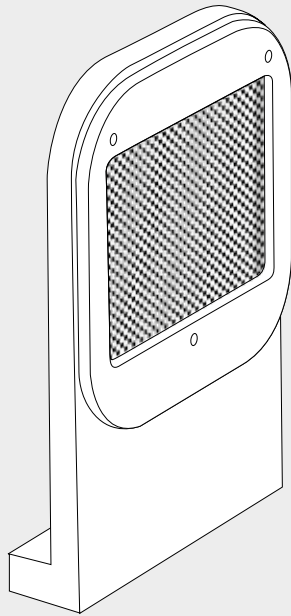
The pattern is assembled on a frame held by three magnets: this floating system allows pattern phase adjustment and proper centering.

Part number	Compatibility	Mechanical specifications			
		Patterns	Width	Height	Thickness
	PT	(mm)	(mm)	(mm)	(g)
<b>CMPH 004-024</b>	004-009, 016-024	45.0	68.5	18.0	78
<b>CMPH 036-056</b>	036-056	81.0	123.1	22.5	257
<b>CMPH 064-096</b>	064-096	129.0	145.5	25.0	611



# PT series

## Calibration patterns

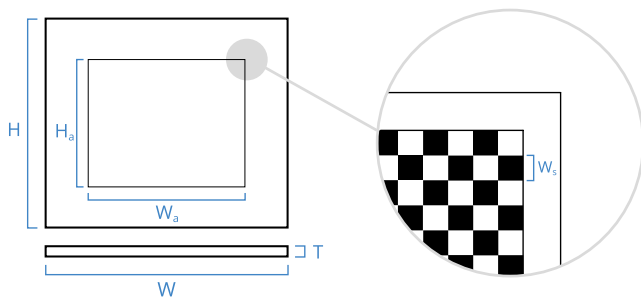


Any machine vision lens (either telecentric or not) shows some amount of distortion. In addition to *barrel* or *pincushion* distortion, changes in the view angle or misaligned components will affect the image symmetry and generate the so-called *thin prism* or *keystone* effect.

Imaging and metrology applications often require to minimize distortion, which can be software-corrected by analyzing the image of a precision pattern whose geometrical features are well known.

For this reason Opto Engineering offers chrome-on-glass patterns optimized for software calibration, featuring extremely high geometrical accuracy thanks to photolithography techniques.

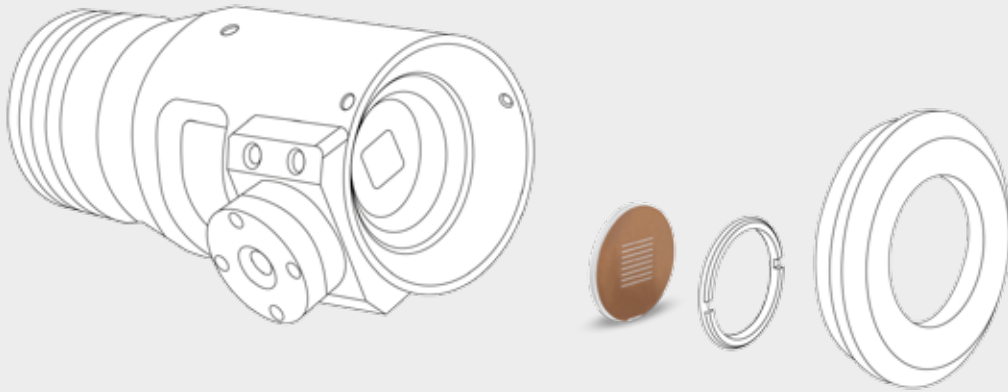
The range of available chessboard patterns is compatible with most Opto Engineering telecentric lenses.



Part number	Compatibility		Mechanical specifications				
	Telecentric lenses (Part numbers ending in)	Pattern mounts CMPH	Dimensions W x H (mm x mm)	Thickness T (mm)	Active area W <sub>a</sub> x H <sub>a</sub> (mm x mm)	Squares W <sub>c</sub> (mm)	Dimensional accuracy (μm)
<b>PT 004-009</b>	004, 007, 009	004-024	33.0 x 26.0	3.0	15.0 x 13.0	0.20	1.3
<b>PT 016-024</b>	016, 024	004-024	33.0 x 26.0	3.0	31.0 x 24.0	0.60	1.5
<b>PT 036-056</b>	036, 048, 056	036-056	66.0 x 52.0	3.0	64.0 x 51.0	1.35	1.9
<b>PT 064-096</b>	064, 072, 080, 085, 096	064-096	107.0 x 83.0	3.0	105.0 x 79.0	2.20	2.4
<b>PT 120-240</b>	110, 120, 130, 144, 172, 192, 200, 240	n.a.	229.0 x 229.0	3.0	208.0 x 208.0	4.00	3.7

# PT series

Patterns for LTPRSM series



## Photolithography stripe patterns



**PT 0000 0300 P**  
line gap 0.95 mm  
line thickness 0.05 mm



**PTST 050 450 P**  
line gap 0.45 mm  
line thickness 0.05 mm



**PTST 050 200 P**  
line gap 0.20 mm  
line thickness 0.05 mm

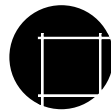


**PTST 050 100 P**  
line gap 0.10 mm  
line thickness 0.05 mm

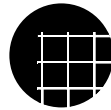


**PTST 050 050 P**  
line gap 0.05 mm  
line thickness 0.05 mm

## Photolithography grid patterns



**PT 0000 0400 P**  
line gap 0.95 mm  
line thickness 0.05 mm



**PTGR 050 450 P**  
line gap 0.45 mm  
line thickness 0.05 mm



**PTGR 050 200 P**  
line gap 0.20 mm  
line thickness 0.05 mm



**PTGR 050 100 P**  
line gap 0.10 mm  
line thickness 0.05 mm

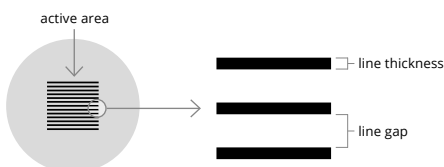


**PTGR 050 050 P**  
line gap 0.05 mm  
line thickness 0.05 mm



Pattern projector for machine vision

## Pattern detail



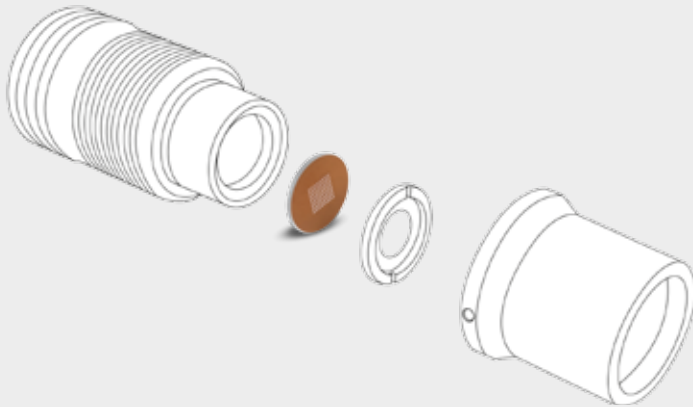
## Pattern specifications

### Photolithography patterns

Substrate	Soda lime glass
Coating	Chrome
Geometrical accuracy	2 µm
Edge sharpness	1.4 µm

# PT series

Patterns for LTPR series



Photolithography pattern



Laser engraved pattern

## Photolithography patterns

**PT 0000 0100 P**  
design: line pattern  
line thickness 0.05 mm

**PT 0000 0200 P**  
design: cross pattern  
line thickness 0.05 mm

**PT 0000 0300 P**  
design: stripe pattern  
line gap 0.95 mm  
line thickness 0.05 mm

**PT 0000 0400 P**  
design: grid pattern  
line gap 0.95 mm  
line thickness 0.05 mm

**PT 0000 0500 P**  
design: edge pattern  
line gap 0.10 mm  
line thickness 0.05 mm

## Laser engraved patterns

**PT 0000 0100 L**  
design: line pattern  
line thickness 0.5 mm

**PT 0000 0200 L**  
design: cross pattern  
line thickness 0.5 mm

**PT 0000 0300 L**  
design: stripe pattern  
line gap 0.5 mm  
line thickness 0.5 mm

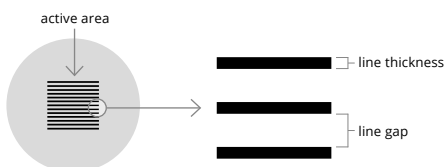
**PT 0000 0400 L**  
design: grid pattern  
line gap 0.8 mm  
line thickness 0.2 mm

**PT 0000 0500 L**  
design: edge pattern  
line gap 0.10 mm  
line thickness 0.5 mm



Pattern projectors for machine vision

## Pattern detail



## Pattern specifications

### Photolithography patterns

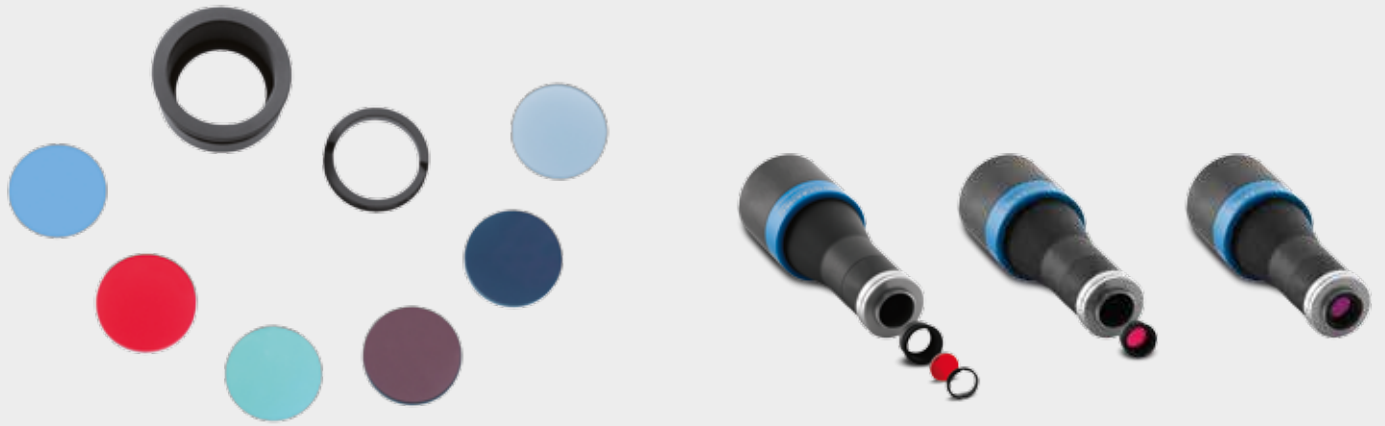
Substrate	Soda lime glass
Coating	Chrome
Geometrical accuracy	2 µm
Edge sharpness	1.4 µm

### Laser engraved patterns

Substrate	Borofloat glass
Coating	Dichroic mirror
Geometrical accuracy	50 µm
Edge sharpness	50 µm

# Optical filters

Lens filters and mounting accessory

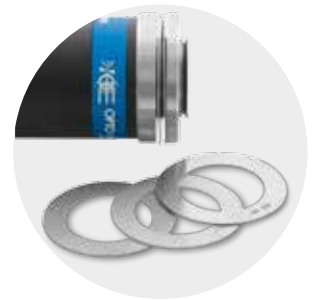


Light filtering is a typical need in machine vision measurement applications. For instance, you may need to avoid possible interactions between your LED illuminator and other light sources in an industrial environment.

Moreover, sun light is very frequently causing errors in imaging systems due to unexpected reflections from the surface of the parts being measured.

In these cases, a band-pass or long-pass filter that matches the emission wavelength of the illuminator is usually integrated in front of the objective: this way, only the light coming from the illuminator is collected while the rest of the spectrum is cut out.

Furthermore, many machine vision applications require monochromatic illumination in order to enhance or suppress particular object features: under these conditions, only the features with a certain color are imaged and can be measured.



Part number	Description	Matching products	Diameter	Weight
<b>Filter mount</b>		<b>Telecentric lenses</b>	(mm)	(g)
<b>TCFILTER</b>	Filter mount for telecentric lenses	TC 12yyy, TC 23yyy, TC2MHRyyy-C, TC4MHRyyy-C <b>1 2 2</b>	-	10
<b>Filters</b>		<b>Collimated illuminators</b>		
<b>COBP470D17.5</b>	Blue (470 nm) bandpass filter	B LED sources	17.5	5
<b>COBP525D17.5</b>	Green (525 nm) bandpass filter	G LED sources	17.5	5
<b>COBP635D17.5</b>	Red (635 nm) bandpass filter	R LED sources	17.5	5
<b>COBP850D17.5</b>	IR (850 nm) bandpass filter	-	17.5	5
<b>COBP880D17.5</b>	IR (880 nm) bandpass filter	-	17.5	5
<b>COLP920D17.5</b>	IR (920 nm) longpass filter	-	17.5	5
<b>COPR032D17.5</b>	Linear polarizer	-	17.5	5

**1** Except TC 23 004, TC 23 007, TC 23 009, TC 23 012.

**2** Some vignetting may occur, depending on sensor size.

## Ordering information

When ordering a filter for a C-mount telecentric lens insert both the filter mount (P/N: TCFILTER) and the optical filter in your order.

For example: if you need a green filter to be mounted onto TC23036 telecentric lens, order both the following items:

- **TCFILTER** - Filter mount for telecentric lenses
- **COBP525D17.5** - Green (525 nm) bandpass filter, 17.5 mm diameter

# Beyond the product

**Being close to our customers, worldwide**, is one of our driving principles: we believe that helping customers get the most value out of our products is the key to establish long-term business relationships.

**Comprehensive support** is the first step: you can send us your own samples for testing at our labs or, if you need to check the whole system in the field, we'll do our best to ship you an evaluation unit.

But what if your production requires a very specific solution? Our proven experience in **special optics development** will make it an easy, fast and cost-effective process.

**Being local** helps reducing delivery times and costs. Also, you can always count on a professional team of sales engineers to help you define your orders and maximize efficiency.

This approach enables us to provide **competitive** solutions with the **flexibility** needed to handle special or high-volume orders.

Wherever you are, whatever you need, we'll be happy to support you with more than just great products... our customer service is **the cherry on the cake**.



## Opto Engineering: close to you, worldwide.

---

### Spare parts and retail products

Our products are complemented by a comprehensive range of spare parts and attachments: cables, replacement optics, power units, LED units, with the documentation needed to perform essential servicing tasks.

Beside our "made in Opto" product range, we offer a selection of general-purpose retail optics suitable for a wide range of applications, spanning from general factory automation to surveillance: standard fixed focal C-mount lenses, vari-focal lenses, macro zoom optics and related accessories.



---

### Tools and resources

Extended documentation is available on our website, localized in nine languages. For every part number you will find full specifications, product compatibilities, 2D and 3D models in the most popular CAD formats. Interactive tools such as the **TC selection form** and the **telecentric/entocentric sensor charts** provide an essential aid in navigating our product range.

Moreover, we regularly publish papers and video guides about Opto Engineering products and technologies as well as broader machine vision optics tutorials.



# Opto Engineering

## Glossary

---

**AOI**

Automated Optical Inspection

**Back lighting**

Placement of a light source behind an object to highlight its shape, useful to hide surface details and emphasize the outline of an object.

**BGA**

Ball-Grid Array - a type of surface-mount packaging used for integrated circuits.

**CTF**

Contrast Transfer Function.

**F-Number, F/#**

The ratio of the lens focal length to the diameter of the entrance pupil.

**FOV or Field of view**

The part which can be seen by the machine vision system at one moment. The field of view depends from the lens of the system and from the working distance between object and camera.

**LED**

Light Emitting Diode.

**Line scan camera**

A camera based on a single row of photodetectors.

**Machine vision**

Also called Artificial Vision, it is a wide-ranging term referring to the applications of computer vision to industry and manufacturing.

**Metrology**

The science of measurement: a key application of many machine vision technologies.

**OCR**

Optical Character Recognition: dedicated software to process images of written text into a computer-understandable format.

**PCB**

Printed Circuit Board.

**Scheimpflug**

Refers to the Scheimpflug principle: a geometric rule that describes the orientation of the plane of focus of an optical system (such as a camera) when the lens plane is not parallel to the image plane.

**SMD**

Surface-Mounted Device.

**Telecentricity**

Refers to the property of a telecentric lens to keep chief optical rays (rays passing through the center of the aperture stop) parallel to the optical axis.

**Working distance, WD**

Distance (usually in mm) from the optimal focus plane where the object is placed to the front end of the lens mechanics.

**Working F-Number, wF/#**

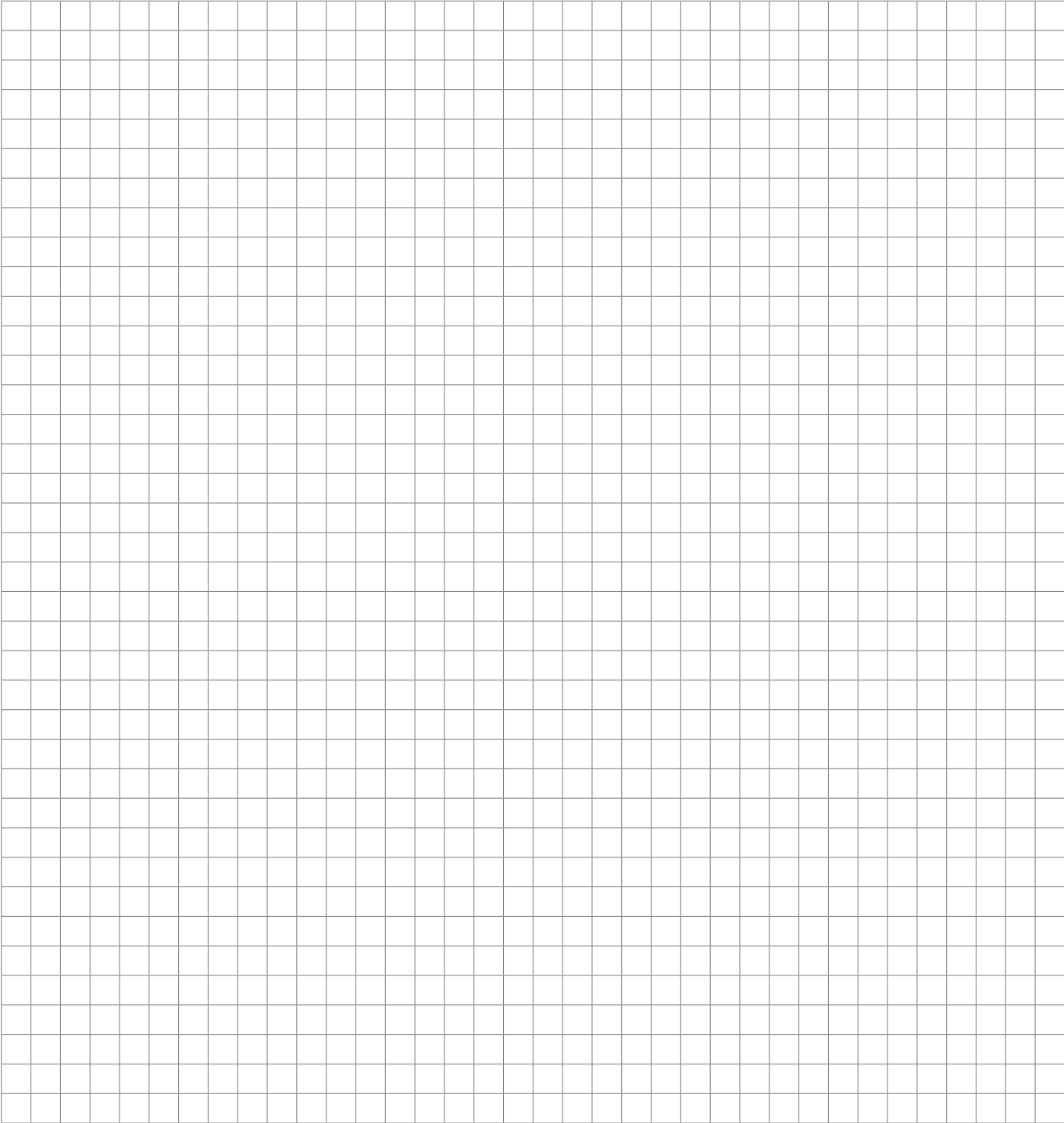
The real F-number of a lens when used as a macro.



# Opto Engineering

Notes

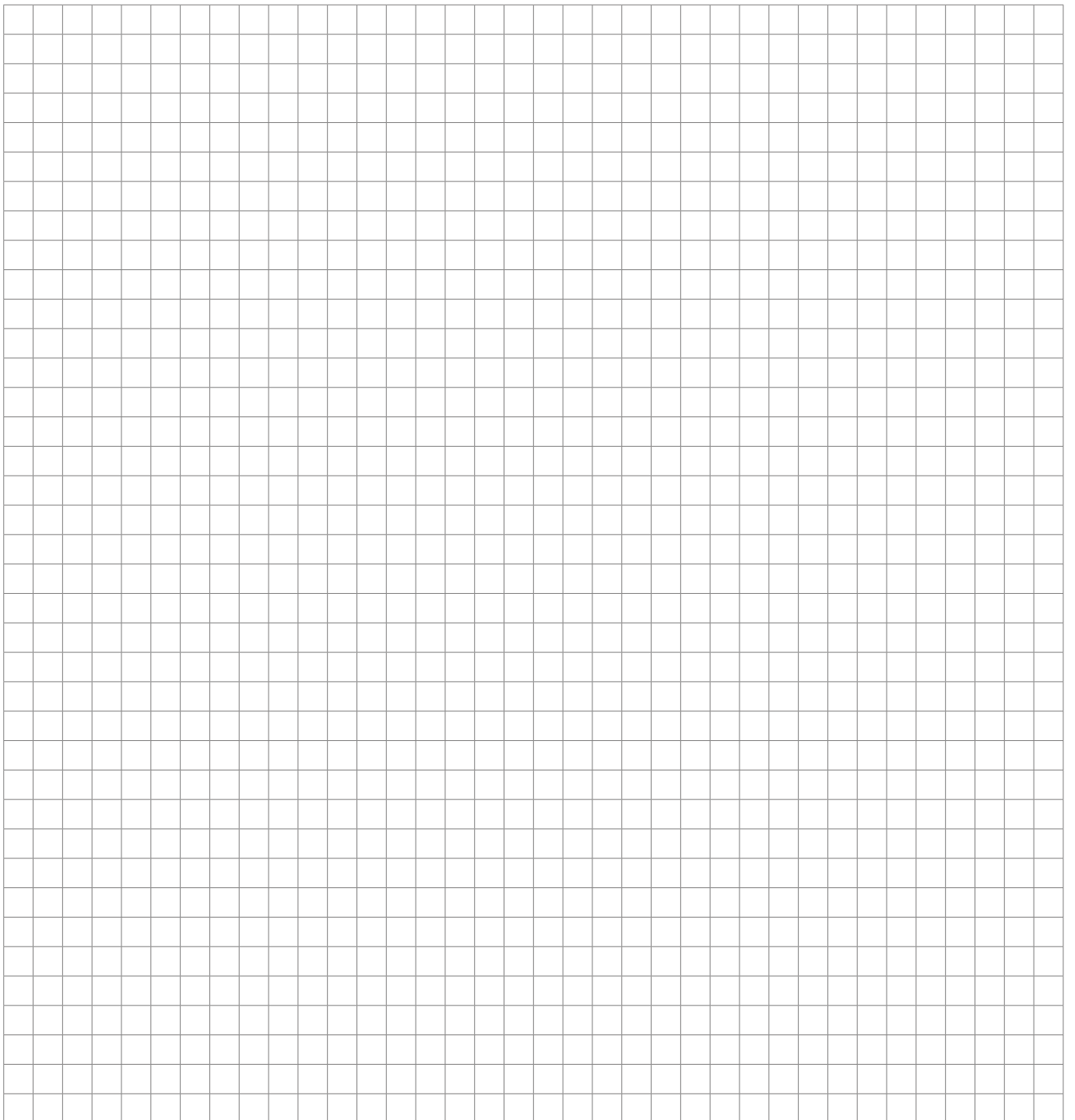
---




# Opto Engineering

Notes

---





All product specifications and data are subject to change without notice to improve reliability, functionality, design or other. Photos and pictures are for illustration purposes only.

If the buyer does not require formally, in writing, that the products conform to specifications of the country of purchase, we feel relieved from having to comply with these requirements. Opto Engineering ensures the compliance of its products to the European Community regulations.

## Contact us

July 2015

### EUROPE

**Opto Engineering  
Europe headquarters**  
Circonvallazione Sud, 15  
46100 Mantova, IT  
phone: +39 0376 699111  
contact@opto-engineering.com

**Opto Engineering  
Germany**  
Agnes-Pockels-Bogen, 1  
80992 München, DE  
phone: +49 0 89 18930918  
de@opto-engineering.com

### UNITED STATES

**Opto Engineering  
USA**  
11261 Richmond Ave  
Ste G-108 - Houston, TX 77082  
phone: +1 832 2129391  
us@opto-engineering.com

### ASIA

**Opto Engineering  
China**  
Room 2405, n°885, Renmin RD  
Huangpu District 200010  
Shanghai, China  
phone: +86 21 61356711  
info@opto-e.cn

**Opto Engineering  
Japan**  
*official partner*  
Optart Corporation  
4-54-5 Kameido Koto-ku  
Tokyo, 136-0071 Japan  
phone: +81-3-5628-5116  
jp@opto-engineering.com

**Opto Engineering  
Korea**  
*official partner*  
Far Island Corporation, Ltd.  
Seoul, Korea  
phone: +82 70 767 86098  
+82 10 396 86098  
kr@opto-engineering.com