TELECENTRIC LENSES

Outstanding optical performance. Unmatched customer service.

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

These products deliver the highest optical performance available on the market:

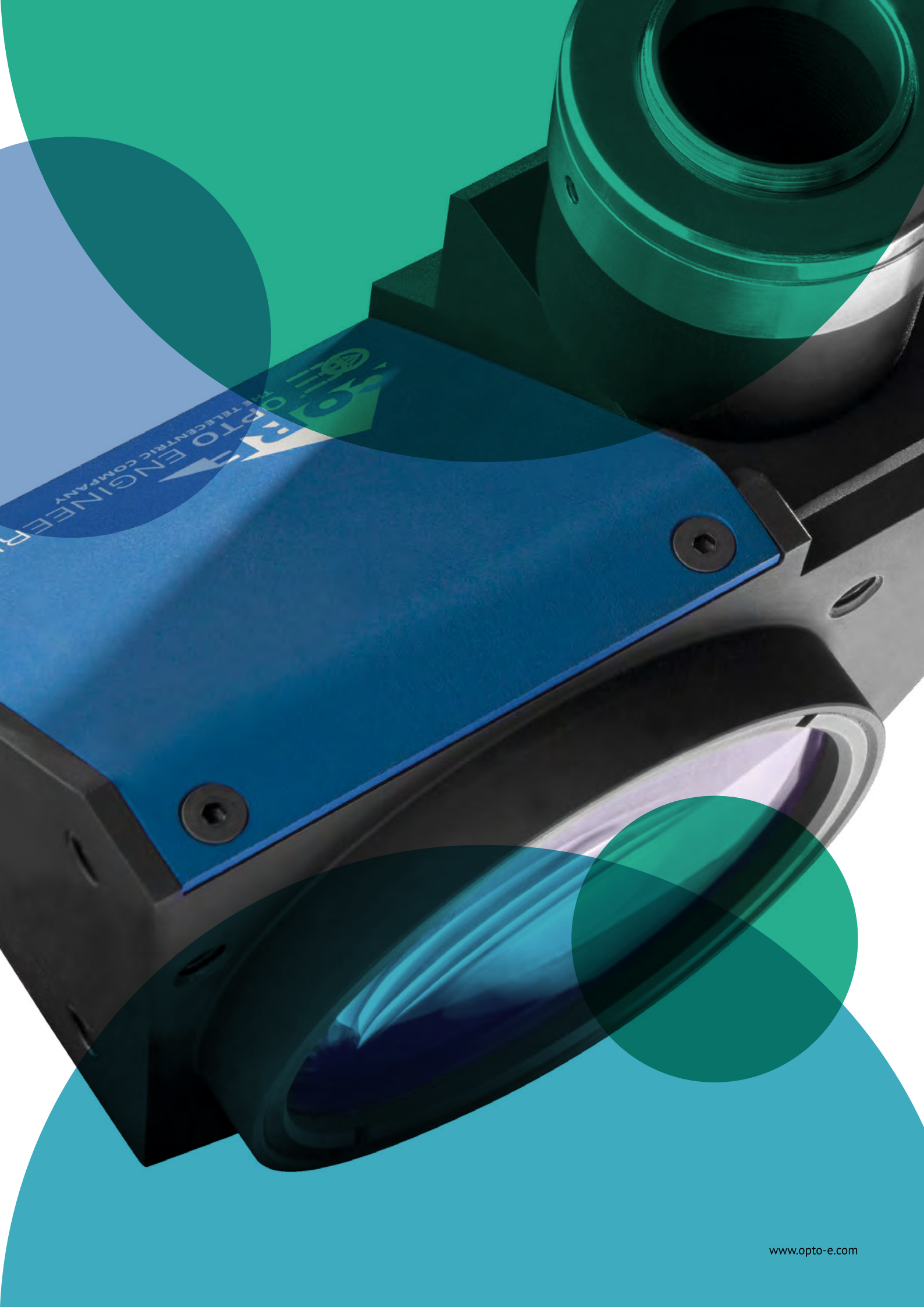
- extra-telecentricity for thick object imaging
- very low distortion for accurate measurements
- excellent resolution for small pixel cameras
- wide field depth for large object displacements
- pre-adjusted back focal length and working distance
- compact and robust design, tailored for industrial environments

TC lenses for matrix detectors also feature:

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

Refer to specific datasheets available at www.opto-e.com for product compliancy with regulations, certifications and safety labels.

INTERNATIONAL PATENT PENDING


OPTO ENGINEERING
THE TELECENTRIC COMPANY

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 Mpix - 2/3", acquiring images with exceptional fidelity and precision.

The Opto Engineering® bi-telecentric design makes these optics truly telecentric: no magnification change occurs when an object is moved closer to or away from the lens, 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 performance in terms of telecentricity and 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.

NEW

Camera phase adjustment available on selected models for easy and hassle-free integration.

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.

FOR HIGHER MAGNIFICATION LENSES SEE ALSO		
	TCHM series	p.46
FULL RANGE OF COMPATIBLE ILLUMINATORS		
	LTCLHP CORE, LTCLHP, LTCLHP CORE PLUS series	p. 132-139
FULL RANGE OF COMPATIBLE ACCESSORIES		
	Mounting mechanics CMHO and CMPT	p. 228-230
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205

			Detector type					Optical specifications							Mechanical specs			
			1/3"	1/2.5"	1/2"	1/1.8"	2/3" - 5 Mpx											
			6.0 mm diag	7.1 mm diag	8.0 mm diag	8.9 mm diag	11.1 mm diag											
Part number	Mag.	Image circle	w x h 4.80 x 3.60	w x h 5.70 x 4.28	w x h 6.40 x 4.80	w x h 7.13 x 5.33	w x h 8.50 x 7.09	WD	wF/#	Telecentricity typical (max)	Distortion typical (max)	Field depth	CTF @70lp/mm		Mount	Phase adj.	Length	Diam.
	(x)	Ø (mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm)		(deg)	(%)	(mm)	(%)				(mm)	(mm)
						7		1	2	3	4	5				9	6	
			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	3.57 x 2.67	4.25 x 3.55	56.0	11	< 0.08 (0.10)	< 0.04 (0.08)	0.2	> 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 4.00	6.38 x 5.32	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 5.33	8.50 x 7.09	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	6.53 x 4.90	7.76 x 5.82	8.71 x 6.53	9.70 x 7.25	11.6 x 9.65	53.9	14	< 0.04 (0.10)	< 0.04 (0.10)	2.1	> 25		C		60.3	28
TC 13 016	0.290	6.0	16.6 x 12.4	ø = 14.8	ø = 16.6	ø = 18.4	ø = 20.7	43.1	8	< 0.04 (0.10)	< 0.04 (0.08)	7.8	> 40		C		80.9	37.7
TC 12 016	0.385	8.0	12.5 x 9.35	14.8 x 11.12	16.6 x 12.5	18.5 x 13.8	ø = 18.4	43.1	8	< 0.04 (0.10)	< 0.04 (0.08)	4.5	> 40		C		93.0	37.7
TC 23 016	0.528	11.0	9.09 x 6.82	10.80 x 8.11	12.1 x 9.09	13.5 x 10.1	16.1 x 13.4	43.1	8	< 0.06 (0.10)	< 0.04 (0.07)	2.4	> 30		C		112.7	37.7
TC 13 024	0.192	6.0	25.0 x 18.8	ø = 22.3	ø = 25.0	ø = 27.8	ø = 31.3	67.2	8	< 0.08 (0.10)	< 0.04 (0.08)	18	> 45		C		105.6	44
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 20.9	ø = 27.8	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 15.2	24.3 x 20.3	67.2	8	< 0.08 (0.10)	< 0.04 (0.10)	5.4	> 45		C		137.5	44
TC 13 036	0.133	6.0	36.1 x 27.1	ø = 32.2	ø = 36.1	ø = 40.1	ø = 45.1	102.5	8	< 0.04 (0.08)	< 0.03 (0.08)	37	> 50		C		133.0	61
TC 12 036	0.177	8.0	27.1 x 20.3	32.2 x 24.2	36.2 x 27.1	40.3 x 30.1	ø = 40.1	102.5	8	< 0.03 (0.08)	< 0.04 (0.10)	21	> 40		C		145.2	61
TC 23 036	0.243	11.0	19.8 x 14.8	23.5 x 17.6	26.3 x 19.8	29.3 x 21.9	35.0 x 29.2	102.5	8	< 0.04 (0.08)	< 0.04 (0.10)	11	> 40		C		164.9	61
TC 13 048	0.098	6.0	49.0 x 36.7	ø = 43.7	ø = 49.0	ø = 54.4	ø = 61.2	133.4	8	< 0.08 (0.10)	< 0.06 (0.10)	69	> 40		C		167.9	75
TC 12 048	0.134	8.0	35.8 x 26.9	42.5 x 31.9	47.8 x 35.8	53.2 x 39.8	ø = 52.9	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 29.0	46.2 x 38.5	132.9	8	< 0.08 (0.10)	< 0.05 (0.10)	19	> 40		C		201.0	75
TC 13 056	0.084	6.0	57.1 x 42.9	ø = 51.0	ø = 57.1	ø = 63.5	ø = 71.4	157.8	8	< 0.04 (0.08)	< 0.04 (0.08)	94	> 50		C		191.5	80
TC 12 056	0.114	8.0	42.1 x 31.6	50.0 x 37.5	56.1 x 42.1	62.5 x 46.8	ø = 62.2	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 27.3	40.8 x 30.6	45.4 x 33.9	54.1 x 45.2	157.8	8	< 0.05 (0.08)	< 0.03 (0.08)	27	> 45		C		225.0	80
TC 13 064	0.074	6.0	64.9 x 48.6	ø = 57.8	ø = 64.9	ø = 72.0	ø = 81.1	181.9	8	< 0.06 (0.08)	< 0.03 (0.07)	121	> 40		C		212.3	100
TC 12 064	0.100	8.0	48.0 x 36.0	57.0 x 42.8	64.0 x 48.0	71.3 x 53.3	ø = 70.9	181.8	8	< 0.05 (0.08)	< 0.04 (0.07)	66	> 50		C		225.9	100
TC 23 064	0.138	11.0	34.8 x 26.1	41.3 x 31.0	46.4 x 34.8	51.7 x 38.6	61.6 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	39.3 x 29.5	46.7 x 35.1	52.5 x 39.3	58.4 x 43.7	69.7 x 58.1	226.7	8	< 0.04 (0.08)	< 0.03 (0.07)	44	> 40		C	Yes	299.2	116
TC 13 080	0.059	6.0	81.4 x 61.0	ø = 72.5	ø = 81.4	ø = 90.3	ø = 101.7	225.9	8	< 0.05 (0.08)	< 0.03 (0.08)	190	> 40		C		259.2	116
TC 12 080	0.080	8.0	60.0 x 45.0	71.3 x 53.5	80.0 x 60.0	89.1 x 66.6	ø = 88.6	226.7	8	< 0.03 (0.08)	< 0.04 (0.10)	103	> 50		C		271.5	116
TC 23 080	0.110	11.0	43.6 x 32.7	51.8 x 38.9	58.2 x 43.6	64.8 x 48.5	77.3 x 64.5	226.7	8	< 0.04 (0.08)	< 0.02 (0.10)	55	> 50		C		291.2	116
TC 23 085	0.104	11.0	46.2 x 34.6	54.8 x 41.2	61.5 x 46.2	68.6 x 51.3	81.7 x 68.2	279.7	8	< 0.04 (0.08)	< 0.02 (0.08)	61	> 45		C	Yes	344.5	143
TC 13 096	0.050	6.0	96.0 x 72.0	ø = 85.6	ø = 96.0	ø = 106.6	ø = 120.0	279.6	8	< 0.06 (0.08)	< 0.04 (0.10)	264	> 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	104.9 x 78.4	ø = 104.3	278.6	8	< 0.06 (0.08)	< 0.03 (0.08)	143	> 45		C		317.0	143
TC 23 096	0.093	11.0	51.6 x 38.7	61.3 x 46.0	68.8 x 51.6	76.7 x 57.3	91.4 x 76.2	278.6	8	< 0.06 (0.08)	< 0.04 (0.08)	76	> 40		C		336.6	143
TC 23 110	0.079	11.0	60.8 x 45.6	72.2 x 54.2	81.0 x 60.8	90.3 x 67.5	107.6 x 89.7	334.5	8	< 0.06 (0.08)	< 0.03 (0.07)	106	> 40		C	Yes	430.4	180
TC 13 120	0.038	6.0	126.3 x 94.7	ø = 112.6	ø = 126.3	ø = 140.3	ø = 157.9	334.5	8	< 0.06 (0.08)	< 0.04 (0.10)	244	> 45		C	Yes	402.7	180
TC 12 120	0.052	8.0	92.3 x 69.2	109.6 x 82.3	123.1 x 92.3	137.1 x 102.5	ø = 136.3	334.5	8	< 0.06 (0.08)	< 0.04 (0.10)	457	> 45		C	Yes	398.1	180
TC 23 120	0.072	11.0	66.7 x 50.0	79.2 x 59.4	88.9 x 66.7	99.0 x 74.0	118.1 x 98.5	334.5	8	< 0.07 (0.08)	< 0.04 (0.10)	127	> 35		C	Yes	422.4	180
TC 23 130	0.068	11.0	70.6 x 52.9	83.8 x 62.9	94.1 x 70.6	104.9 x 78.4	125.0 x 104.3	396.0	8	< 0.05 (0.08)	< 0.04 (0.10)	143	> 40		C	Yes	490.0	200
TC 13 144	0.033	6.0	145.5 x 109.1	ø = 129.7	ø = 145.5	ø = 161.5	ø = 181.8	396.0	8	< 0.05 (0.08)	< 0.04 (0.10)	606	> 45		C	Yes	448.8	200
TC 12 144	0.044	8.0	109.1 x 81.8	129.5 x 97.3	145.5 x 109.1	162.0 x 121.1	ø = 161.1	396.0	8	< 0.05 (0.08)	< 0.05 (0.08)	341	> 35		C	Yes	462.1	200
TC 23 144	0.061	11.0	78.7 x 59.0	93.4 x 70.2	104.9 x 78.7	116.9 x 87.4	139.3 x 116.2	396.0	8	< 0.05 (0.08)	< 0.04 (0.08)	177	> 40		C	Yes	481.9	200
TC 23 172	0.051	11.0	94.1 x 70.6	111.8 x 83.9	125.5 x 94.1	139.8 x 104.5	166.7 x 139.0	526.9	8	< 0.05 (0.08)	< 0.04 (0.10)	254	> 40		C	Yes	630.3	260
TC 13 192	0.025	6.0	192.0 x 144.0	ø = 171.2	ø = 192.0	ø = 213.2	ø = 240.0	527.0	8	< 0.06 (0.08)	< 0.04 (0.10)	1056	> 45		C	Yes	598.2	260
TC 12 192	0.033	8.0	145.5 x 109.1	172.7 x 129.7	193.9 x 145.5	216.1 x 161.5	ø = 214.8	526.9	8	< 0.06 (0.08)	< 0.04 (0.08)	606	> 45		C	Yes	602.6	260
TC 23 192	0.046	11.0	104.3 x 78.3	123.9 x 93.0	139.1 x 104.3	155.0 x 115.9	184.8 x 154.1	526.9	8	< 0.06 (0.08)	< 0.05 (0.08)	312	> 35		C	Yes	622.3	260
TC 23 200	0.044	11.0	109.1 x 81.8	129.5 x 97.3	145.5 x 109.1	162.0 x 121.1	193.2 x 161.1	492.8	8	< 0.06 (0.08)	< 0.05 (0.10)	341	> 40		C	Yes	792.0	322
TC 23 240	0.037	11.0	129.7 x 97.3	154.1 x 115.7	173.0 x 129.7	192.7 x 144.1	229.7 x 191.6	492.8	8	< 0.03 (0.08)	< 0.04 (0.08)	482	> 45		C	Yes	775.1	322

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 (higher wF#) can be supplied on request.
3 Maximum slope of chief rays inside the lens: when converted to millirad, 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 very 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.
7 With 1/1.8" (8.9 mm diagonal) detectors, the FOV of TC12yyy lenses may show some vignetting at the image corners, as these lenses are optimized for 1/2" detectors (8.0 mm diagonal).
8 For the fields with the indication "Ø =", the image of a circular object of such diameter is fully inscribed into the detector.
9 Indicates the availability of an integrated camera phase adjustment feature. If missing, it can be supplied upon request (except for TC23004, TC23007, TC23009, TC23012).

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 horizontal field of view (FOV), in millimeters. For instance, a TC12064 features a field of view of 64 (x 48) mm with a 1/2" camera sensor.

TC CORE series

Ultra compact bi-telecentric lenses up to 2/3"

Vision Systems Design 2016 Innovators Awards GOLD

inVISION TOP INNOVATION 2016

KEY ADVANTAGES

Excellent optical performance
TC CORE bi-telecentric lenses deliver excellent optical performance as other comparable Opto Engineering® bi-telecentric lenses.

Extremely compact
TC CORE lenses are up to 70% smaller than other telecentric lenses on the market.

Designed for flexibility and smart integration
TC CORE lenses integrate a camera phase adjustment and can be mounted on multiple sides with or without clamps, allowing you to cut costs.

Save you money
Systems integrating TC CORE lenses take much less space, resulting in lower manufacturing, shipping and storage costs.

Boost your sales
A smaller vision system or measurement machine is the solution preferred by the industry.

Detailed test report with measured optical parameters.

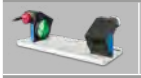
TC CORE bi-telecentric lenses for sensors up to 2/3" feature a truly revolutionary ultra compact opto-mechanical design.

These lenses deliver high-end optical performance and at the same time are up to 70% smaller than other double-sided telecentric lenses on the market, thus allowing you to significantly downsize a vision system.
The unique shape has been expressly developed for maximum mounting flexibility.

TC CORE lenses can be mounted in different directions using any of the 4 sides even without clamps, allowing you to cut the system's cost, and can be easily fitted or retrofitted even into very compact machines.

TC CORE bi-telecentric lenses can also be coupled with the new ultra compact LTCLHP CORE series telecentric illuminators to build super small yet extremely accurate measurement systems.

Comparison of a "classic" telecentric lens present on the market and a TC CORE bi-telecentric lens: TC CORE lens delivers best optical performance and is extremely compact.

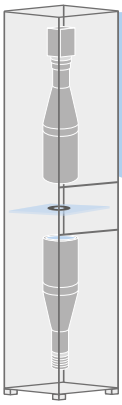
SEE ALSO		
	TCBENCH CORE series	p. 42
FULL RANGE OF COMPATIBLE ILLUMINATORS		
	LTCLHP CORE series	p. 134
FULL RANGE OF COMPATIBLE ACCESSORIES		
	Mounting mechanics CMHOCR and CMPTCR series	p. 231
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205

Multiple lens surfaces can be used for direct mounting without clamps, thanks to the M6 threaded holes located on 4 sides.This also allows you to cut costs.

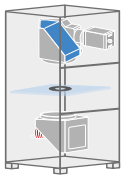
Front CMHOCR clamp available for added mounting flexibility.

Built-in phase adjustment makes it easy to align the camera sensor.

Off-line precision measurement systems:



Save up to **70%** in height



Integrates a classic telecentric lens and a classic telecentric illuminator present on the market.

Integrates a TC CORE bi-telecentric lens and LTCLHP CORE telecentric illuminator.

ADVANTAGES

Save more

- Lower manufacturing cost due to less material employed
- Less space required for storage and use
- Lower shipment expenses due to smaller size
- Lower transportation risks

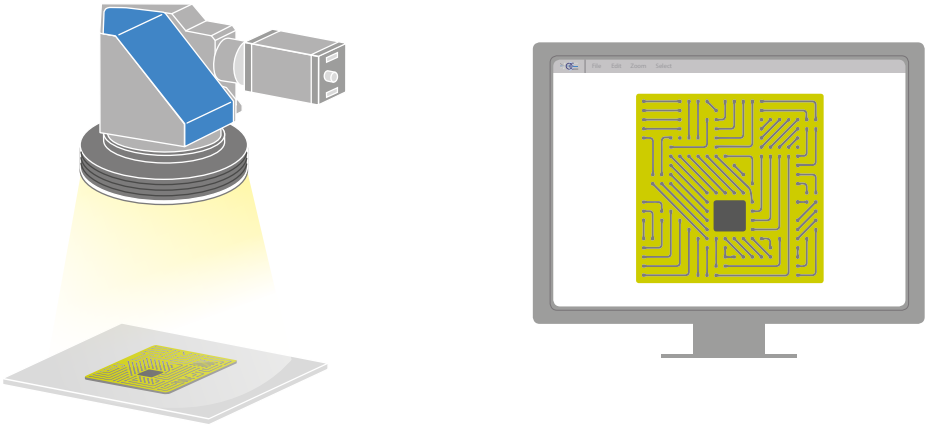
Sell more

- A smaller vision system or measurement machine is preferred by the industry

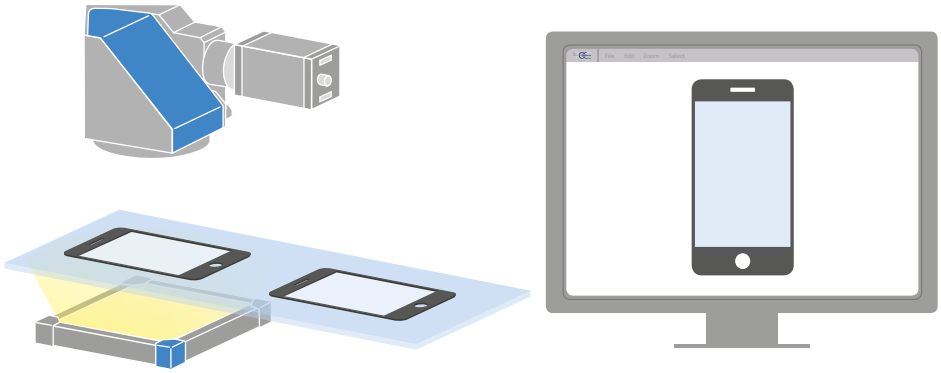
TC CORE series

Ultra compact bi-telecentric lenses up to 2/3"

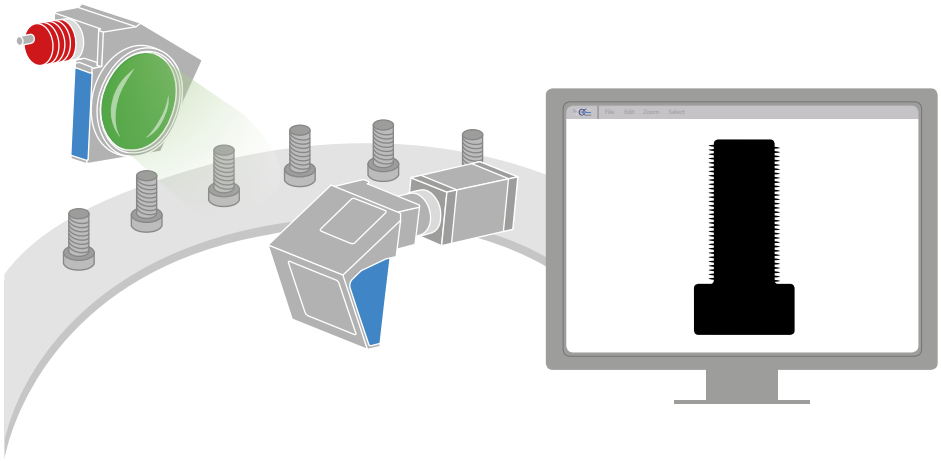
Application examples



Electronic board inspection:
TC CORE with top ringlight.

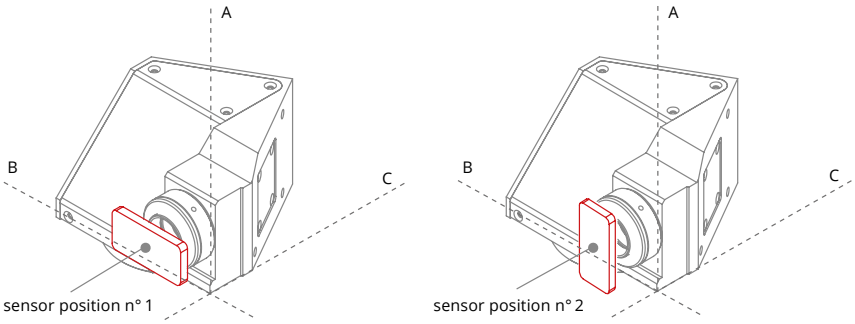


Smartphone glass inspection:
TC CORE mounted directly
on a plate and a flat backlight.



Screw measurement on a rotary
glass table: TC CORE lens
and LTCLHP CORE illuminator.

TC CORE lens dimensions (A, B, C) and correct position of the sensor in relation to the lens:



The long side of sensor has to be aligned along axis B (position n°1) or axis A (pisition n°2).

Technical information:

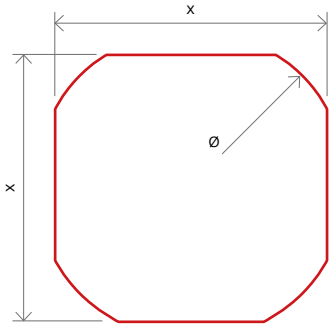


Image shape dimensions (Ø, x).

			Detector type					Optical specifications						Mechanical specs				
Part number	**Mag.** (x)	**Image shape dimensions** Ø, x (mm) **8** **9**	**1/3" 6.0 mm diag w x h** 4.8 x 3.6 (mm × mm)	**1/2.5" 7.1 mm diag w x h** 5.70 x 4.28 (mm × mm)	**1/2" 8.0 mm diag w x h** 6.4 x 4.8 (mm × mm)	**1/1.8" 8.9 mm diag w x h** 7.13 x 5.33 (mm × mm)	**2/3" - 5 MP 11.1 mm diag w x h** 8.50 x 7.09 (mm × mm)	**WD** (mm) **1**	**wF/#** **2**	**Telecentricity** typical (max) (deg) **3**	**Distortion** typical (max) (%) **4**	**Field depth** (mm) **5**	**CTF** @70 lp/mm (%)	**Mount**	**Phase adj.** **7**	**Dimensions** (mm) **A**	**B**	**C**
			Object field of view (mm x mm) **6**															
TCCR 12 048	0.134	Ø=8.0, x=7.1	35.8 x 26.9	42.5 x 31.9	47.8 x 35.8	53.2 x 39.8	Ø=60, x=53	132.9	8	< 0.07 (0.10)	< 0.06 (0.10)	37	> 40	C	Yes	77	106	115
TCCR 23 048	0.184	Ø=11.0, x=9.6	26.1 x 19.6	31.0 x 23.3	34.8 x 26.1	38.8 x 29.0	46.2 x 38.5	132.9	8	< 0.08 (0.10)	< 0.05 (0.10)	19	> 40	C	Yes	77	106	135
TCCR 12 056	0.114	Ø=8.1, x=7.1	42.1 x 31.6	50.0 x 37.5	56.1 x 42.1	62.5 x 46.8	Ø=71, x=62	157.8	8	< 0.04 (0.08)	< 0.04 (0.10)	51	> 50	C	Yes	94	110	125
TCCR 23 056	0.157	Ø=11.1, x=9.6	30.6 x 22.9	36.3 x 27.3	40.8 x 30.6	45.4 x 33.9	54.1 x 45.2	157.8	8	< 0.05 (0.08)	< 0.03 (0.10)	27	> 45	C	Yes	94	110	145
TCCR 12 064	0.100	Ø=8.4, x=6.9	48.0 x 36.0	57.0 x 42.8	64.0 x 48.0	71.3 x 53.3	Ø=84, x=69	181.8	8	< 0.05 (0.08)	< 0.04 (0.10)	66	> 50	C	Yes	101	122	133
TCCR 23 064	0.138	Ø=11.5, x=9.5	34.8 x 26.1	41.3 x 31.0	46.4 x 34.8	51.7 x 38.6	61.6 x 51.4	181.8	8	< 0.05 (0.08)	< 0.03 (0.10)	35	> 50	C	Yes	101	122	153
TCCR 12 080	0.080	Ø=8.1, x=6.9	60.0 x 45.0	71.3 x 53.5	80.0 x 60.0	89.1 x 66.6	Ø=101, x=86	226.7	8	< 0.03 (0.08)	< 0.04 (0.10)	103	> 50	C	Yes	119	145	159
TCCR 23 080	0.110	Ø=11.1, x=9.6	43.6 x 32.7	51.8 x 38.9	58.2 x 43.6	64.8 x 48.5	77.3 x 64.5	226.7	8	< 0.04 (0.08)	< 0.02 (0.10)	55	> 50	C	Yes	119	145	172
TCCR 12 096	0.068	Ø=8.3, x=6.8	70.6 x 52.9	83.8 x 62.9	94.1 x 70.6	104.9 x 78.4	Ø=122, x=100	278.6	8	< 0.06 (0.08)	< 0.03 (0.10)	143	> 45	C	Yes	139	172	183
TCCR 23 096	0.093	Ø=11.4, x=9.4	51.6 x 38.7	61.3 x 46.0	68.8 x 51.6	76.7 x 57.3	91.4 x 76.2	278.6	8	< 0.06 (0.08)	< 0.04 (0.10)	76	> 40	C	Yes	139	172	197
TCCR 12 120	0.052	Ø=8.2, x=6.7	92.3 x 69.2	109.6 x 82.3	123.1 x 92.3	137.1 x 102.5	Ø=157, x=128	334.5	8	< 0.06 (0.08)	< 0.08 (0.10)	244	> 45	C	Yes	182	220	231
TCCR 23 120	0.072	Ø=11.2, x=9.3	66.7 x 50.0	79.2 x 59.4	88.9 x 66.7	99.0 x 74.0	118.1 x 98.5	334.5	8	< 0.06 (0.08)	< 0.08 (0.10)	127	> 35	C	Yes	182	220	231

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 (higher wF#) can be supplied on request.
3 Maximum slope of chief rays inside the lens: when converted to millirad, 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 In case the of vignetting, FOV dimensions are indicated with "Ø = , x= ", where "Ø =" stands for diameter and "x=" indicates the nominal FOV height and length (see Tech Info for related drawing).
7 Indicates the availability of an integrated camera phase adjustment feature.
8 Due to the special shape of TCCRxx120 it might be necessary to check the mechanical compatibility with your camera.
9 Indicates the dimensions and shape of image, where "Ø =" stands for diameter and "x=" indicates the nominal image height and length (Tech Info for related drawing).

TC CORE PLUS series

Ultra compact large FOV telecentric lenses for matrix detectors up to 2/3"

NEW

INTERNATIONAL PATENT PENDING

KEY ADVANTAGES

Large FOV in a super compact form factor
TC CORE PLUS telecentric lenses are up to 45% shorter than other telecentric lenses on the market. They are designed to image extremely large FOVs in a reduced space.

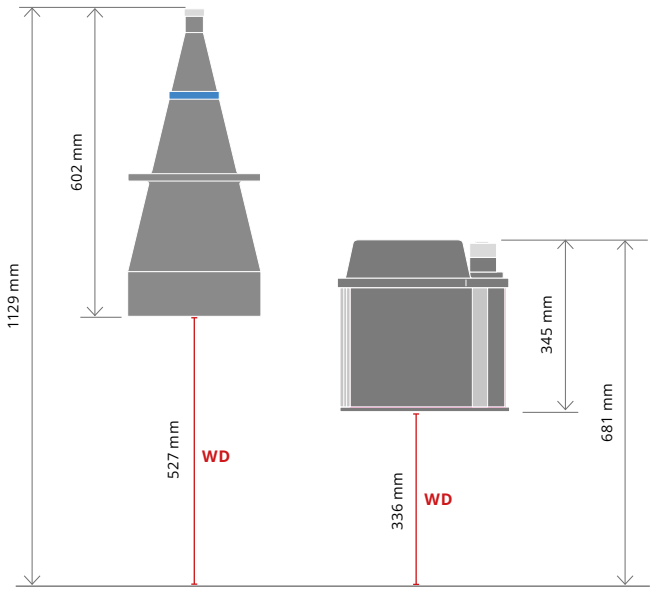
Optimized working distance
Working distance of TC CORE PLUS lenses has been reduced to greatly minimize system dimensions.

Smart integration
TC CORE PLUS lenses integrate a mounting flange for easy integration without additional clamps.

Boost your sales
TC CORE PLUS lenses allow you to reduce the size of your vision system, resulting in less manufacturing, shipping and storage costs.

TC CORE PLUS series are large FOV telecentric lenses for area scan cameras, specifically designed for the latest generation 1/1.8" and 2/3" CMOS sensors. Their opto-mechanical design is ideal to measure large objects in a reduced space.
TC CORE PLUS series are up to 45% shorter than other telecentric lenses available on the market.

Their patent-pending optical design, inspired by catadioptric telescopes, allows for large FOV imaging while keeping the overall footprint compact.
The length and working distance of a telecentric lens strongly impacts the size of a vision system. This is especially critical when a large FOV telecentric lens is used with a telecentric illuminator, as the overall system dimensions are doubled. For this reason, the working distance of TC CORE PLUS lenses has been optimized to make a measurement system as compact as possible. TC CORE PLUS lenses feature a built-in mounting flange and standard aluminum T-slot profiles for easy mounting without additional clamps, making their integration easy and cost-effective.

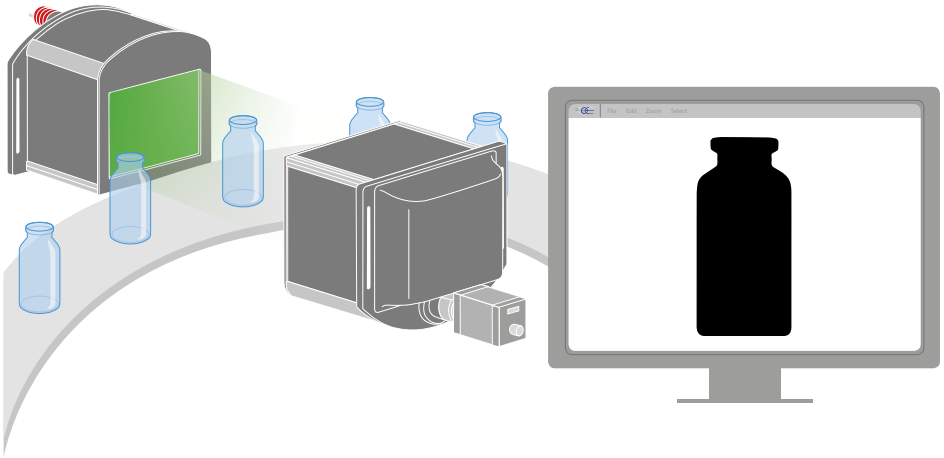


Example: comparison between TC12192 (left) and TCCP12192 (right) lenses with 0.033x mag. and a FOV of 195 x 146mm.

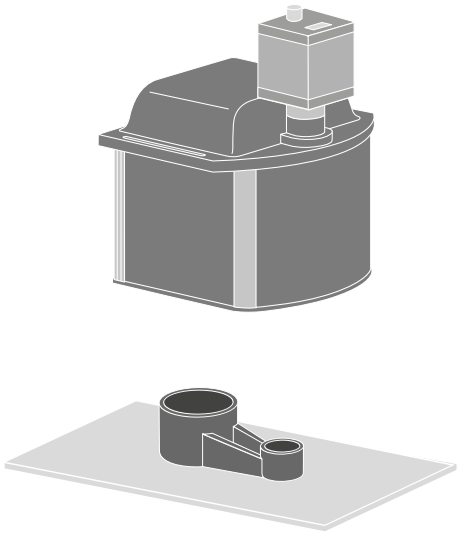
	Mag. (x)	1/1.8" sensor FOV (mm x mm)	WD (mm)	Lens length (mm)	Overall system height (mm)
TC12192	0.033	216 x 162	527	602	1129
TCCP12192	0.033	216 x 162	336	345	681
With CORE PLUS telecentric lens you save:	- -	- -	**191 (36%)**	**257 (43%)**	**448 (40%)**

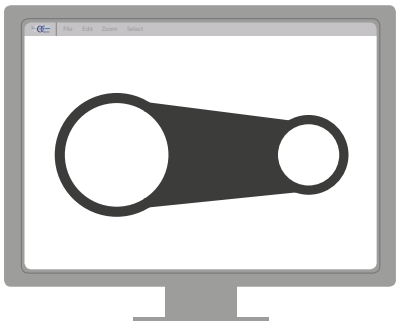
TCCP12192 provides a 216mm x 162mm FOV with a 1/1.8" sensor (same as TC12192). Being 257mm smaller and having a 191mm shorter working distance, it allows you to save almost 450mm.

Application examples:

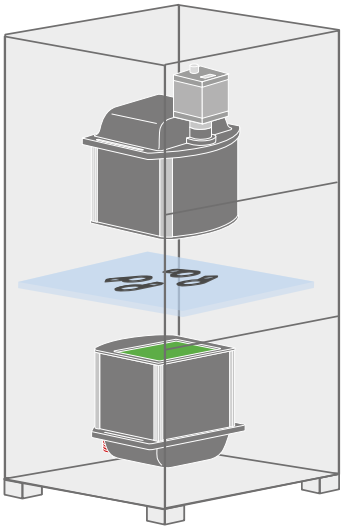


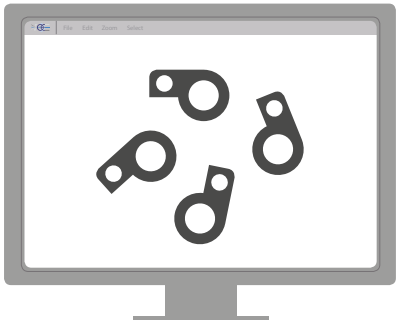
Bottles measurement.





Large mechanical parts measurement.



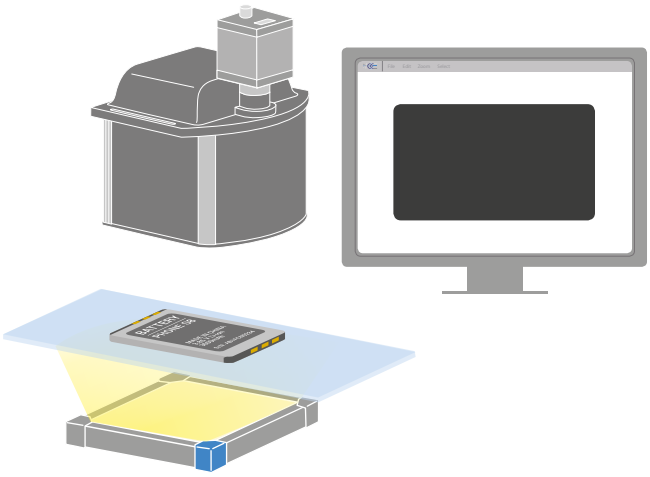


2D profile measurement of multiple parts.

TC CORE PLUS series

Ultra compact large FOV telecentric lenses for matrix detectors up to 2/3"

Application example:



Smartphone and tablet battery measurement.

ADVANTAGES

Save more

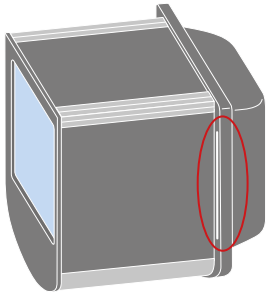
- Lower manufacturing cost due to less material employed
- Cost of mounting is reduced as no addictional clamps are needed
- Less space required for storage and use
- Lower shipment expenses due to smaller size
- Lower transportation risks

Sell more

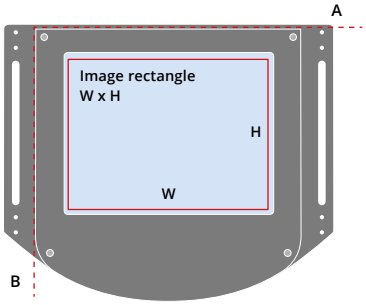
- A smaller system leads to more sales

Compatible backlights		LT2BC series		LTBC series		LTBP series	
	FOV max. (mm)	**Part Number**	**Lighting area dim.** (mm)	**Part Number**	**Lighting area dim.** (mm)	**Part Number**	**Lighting area dim.** (mm)
TCCP 12 144	161.8 x 121.1	LT2BC192144-X	192 x 144	LTBC174174-X	174.5 x 174.5	LTBP192144-X	192 x 144
TCCP 23 144	145.1 x 121.0	LT2BC192144-X	192 x 144	LTBC174174-X	174.5 x 174.5	LTBP192144-X	192 x 144
TCCP 12 192	216.4 x 162.0	LT2BC240180-X	240 x 180	LTBC234234-X	234.5 x 234.5	LTBP240180-X	240 x 180
TCCP 23 192	194.1 x 161.9	LT2BC240180-X	240 x 180	LTBC234234-X	234.5 x 234.5	LTBP240180-X	240 x 180

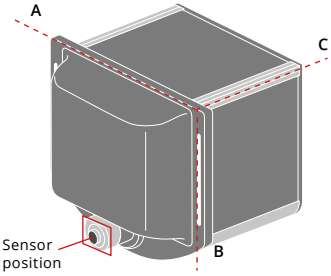
TC CORE PLUS lenses take less space in your system, resulting in less manufacturing, shipping and storage costs.
A smaller vision system or measurement machine is the preferred solution in the industry.



Built-in mounting flange: no additional clamps required.



The width of the FOV (W) is aligned along the A axis.
The heigth of the FOV (H) is aligned along the B axis.

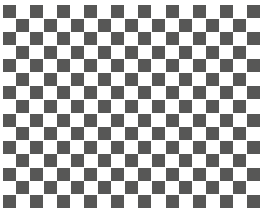


The long side of the sensor has to be aligned along the A axis.

FULL RANGE OF COMPATIBLE ILLUMINATORS		
	LTCLHP CORE PLUS series	p. 138
	LED backlights LT2BC, LTBC, LTBP series	p. 162-171
FULL RANGE OF COMPATIBLE ACCESSORIES		
	PTCP calibration patterns	p. 250
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205

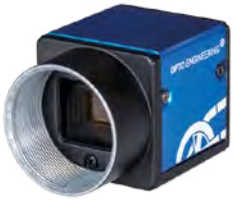
Recommended product setup:

TC CORE PLUS telecentric lens



PTCPxxxxx calibration chess-board pattern

TCLIB Suite software library



Fully GenICam® compliant camera

For best measurement accuracy, TC CORE PLUS telecentric lenses should be used with:

- TCLIB Suite, an Opto Engineering® proprietary software library for distortion calibration and overall optimization of telecentric measurement setups (see pag. 214)
- a fully GenICam® compliant camera (see pag. 196-205)
- a specifically designed PTCPxxxxx chessboard calibration pattern (see pag. 250)

			Detector type					Optical specifications							Mechanical specifications				
Part number	Mag.	Image rectangle	1/3" 6.0 mm diag w x h 4.8 x 3.6 (mm x mm)	1/2.5" 7.1 mm diag w x h 5.7 x 4.28 (mm x mm)	1/2" 8.0 mm diag w x h 6.4 x 4.8 (mm x mm)	1/1.8" 8.9 mm diag w x h 7.12 x 5.33 (mm x mm)	2/3" - 5 MP 11.1 mm diag w x h 8.50 x 7.09 (mm x mm)	WD (mm) 2	wF/# 3	Tele-centricity (max) (deg) 4	Distor-tion (max) (%) 5	Residual distortion 6	Field depth (mm) 7	CTF @50lp/mm (%)	Mount	Phase adj. 8	Dimensions (mm) A 9	B	C 10
	(x)	(mm x mm) 1	Object field of view (mm x mm)																
TCCP 12 144	0.044	7.48 x 5.60	109.1 x 81.8	129.5 x 97.3	145.5 x 109.1	162.0 x 121.1		217.4	8	< 0.08 (0.1)	< 0.6	< 0.01	214	> 45	C	Yes	332.0	302.5	299.4
TCCP 23 144	0.059	8.93 x 7.45	81.9 x 61.4	97.3 x 73.0	109.2 x 81.9	121.7 x 91.0	145.1 x 121.0	217.4	8	< 0.08 (0.1)	< 0.6	< 0.01	121	> 45	C	Yes	332.0	302.5	315.1
TCCP 12 192	0.033	7.48 x 5.60	145.9 x 109.4	173.3 x 130.1	194.5 x 145.9	216.7 x 162.0		328.0	8	< 0.08 (0.1)	< 0.6	< 0.01	382	> 45	C	Yes	410.4	344.1	345.0
TCCP 23 192	0.044	8.93 x 7.45	109.6 x 82.2	130.1 x 97.7	146.1 x 109.6	162.8 x 121.7	194.1 x 161.9	328.0	8	< 0.08 (0.1)	< 0.6	< 0.01	216	> 45	C	Yes	410.4	344.1	353.3

Residual distortion after calibration with TCLIB Suite software library, using PTCPXXX calibration pattern and fully GenICam® compliant camera.
For specific setup information see the table below:

Part number	Calibrations software	Calibrations pattern	Setup camera	Recommended cameras	Recommended sensors
TCCP 12 144	TCLIB Suite	PTCP-S1-HR1-C	RT-mvBF3-2124aG	COE-032-x-POE-040-yy-C, RT-mvBF3-2032a, RT-mvBC-XD104h, RT-mvBC-X104i	IMX252, IMX265
TCCP 23 144	TCLIB Suite	PTCP-S1-HR1-C	RT-mvBF3-2124aG	COE-050-x-z-050-yy-C, RT-mvBF3-2051G, RT-mvBF3-2051aG, RT-mvBC-XD105a, RT-mvBC-X105b	IMX250, IMX264
TCCP 12 192	TCLIB Suite	PTCP-L1-LR1-C	RT-mvBF3-2124aG	COE-032-x-POE-040-yy-C, RT-mvBF3-2032a, RT-mvBC-XD104h, RT-mvBC-X104i	IMX252, IMX265
TCCP 23 192	TCLIB Suite	PTCP-L1-LR1-C	RT-mvBF3-2124aG	COE-050-x-z-050-yy-C, RT-mvBF3-2051G, RT-mvBF3-2051aG, RT-mvBC-XD105a, RT-mvBC-X105b	IMX250, IMX264

1 Since the square shape of the front window the lens forms a rectangular image.
2 Working distance: distance between the front end of the mechanics and the object. Set this distance within +/- 5% of the nominal value for maximum resolution and minimum distortion.
3 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. Typical (average production) values and maximum (guaranteed) values are listed.
4 Maximum slope of chief rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement. Maximum (guaranteed) values are listed.
5 Percent deviation of the real image compared to an ideal, undistorted image. Maximum (guaranteed) values of the uncorrected image are listed.
6 Residual distortion after calibration with TCLIB Suite software library, using a PTCP calibrations pattern and a fully GenICam® compliant camera. For setup information see related table.
7 At the borders of the field depth the image can be still used for measurement but, to get a very sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 3.45 µm.
8 Indicates the availability of an integrated camera phase adjustment feature.
9 Maximum dimension of the clamping flange.
10 Measured from the front end of the mechanics to the camera flange.

TCUV series

UV bi-telecentric lenses

TCUV series bi-telecentric lenses are specifically designed to ensure the highest image resolution today available in the machine vision world.

No other lenses in the market can efficiently operate with pixels as small as 2 microns. For this reason TCUV bi-telecentric lenses are a MUST for all those using high resolution cameras and seeking for the highest system accuracy.

Common lenses and traditional telecentric lenses operate in the visible light (VIS) range. The maximum resolution of a lens is given by the cut-off frequency, that is the spatial frequency at which the lens is no longer able to yield sufficient image contrast.

Since the cut-off frequency is inversely proportional to the light wavelength, common optics are useless with very small pixel sizes (such as 1.75 microns) which are becoming increasingly popular among industrial cameras.

KEY ADVANTAGES

Extremely high resolution for cameras with very small pixels.

High telecentricity for thick object imaging.

Nearly zero distortion for accurate measurements.

Detailed test report with measured optical parameters.

Application examples

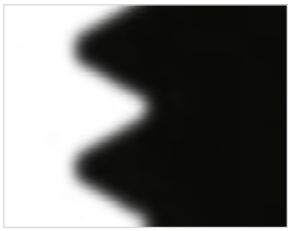


Image captured with a lens operating in the visible range.

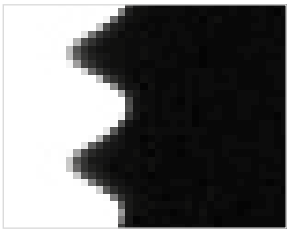
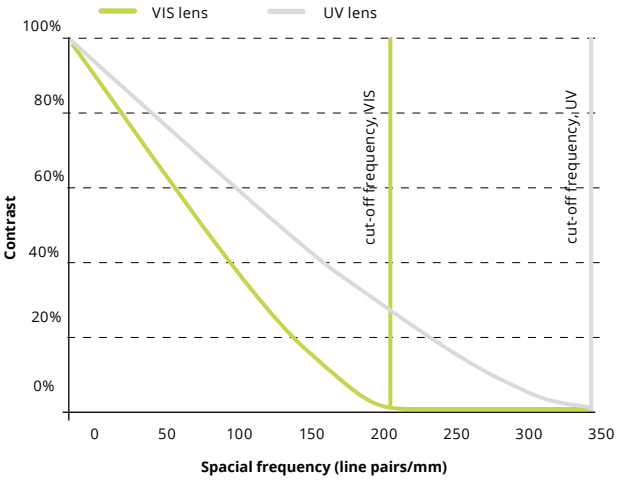
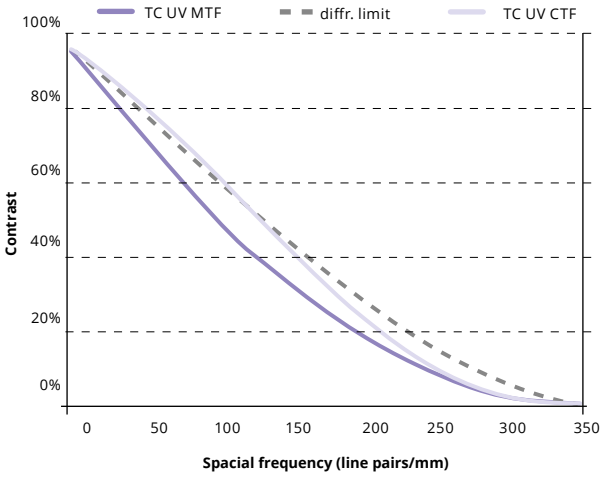


Image taken with a TCUV bi-telecentric lens.

FULL RANGE OF COMPATIBLE ACCESSORIES		
	CMHO series	p. 228
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205



The graph shows the limit performance (diffraction limit) of two lenses operating at working F/# 8.
The standard lens operates at 587 nm (green light) while the UV lens operates at 365 nm.



The CTF function, which expresses the contrast ratio at a given spatial frequency is much higher with TCUV lenses.
The vertical bars show the cut-off frequencies of each lens: TCUV lenses still yield some contrast up to 340 lp/ mm.

			Detector type					Optical specifications						Mechanical specs			
Part number	**Mag.**	**Image circle**	**1/3" 6.0 mm diag w x h** 4.80 x 3.60 (mm x mm)	**1/2.5" 7.1 mm diag w x h** 5.70 x 4.28 (mm x mm)	**1/2" 8.0 mm diag w x h** 6.40 x 4.80 (mm x mm)	**1/1.8" 8.9 mm diag w x h** 7.13 x 5.33 (mm x mm)	**2/3" 11.1 mm diag w x h** 8.50 x 7.09 (mm x mm)	**WD** (mm)	**wF/#**	**Telecentricity** typical (max) (deg)	**Distortion** typical (max) (%)	**Field depth** (mm)	**CTF** @70lp/mm (%)	**Mount**	**Phase adj.**	**Length** (mm)	**Diam.** (mm)
	(x)	Ø (mm)	Object field of view (mm x mm) **9**			**8**		**1**	**2**	**3**	**4**	**5**	**6**		**10**	**7**	
TCUV 12 036	0.175	8	27.4 x 20.6	32.6 x 24.5	36.6 x 27.4	40.7 x 30.5	ø = 40.5	98.7	8	< 0.1	< 0.08	21.6	> 40	C		142.3	61
TCUV 12 048	0.133	8	36.1 x 27.1	42.9 x 32.2	48.1 x 36.1	53.6 x 40.1	ø = 53.3	130.7	8	< 0.08	< 0.08	37.3	> 40	C		176.1	75
TCUV 12 056	0.114	8	42.1 x 31.6	50.0 x 37.5	56.1 x 42.1	62.5 x 46.8	ø = 62.2	154.0	8	< 0.1	< 0.08	50.8	> 40	C		198.4	80
TCUV 12 064	0.100	8	48.0 x 36.0	57.0 x 42.8	64.0 x 48.0	71.3 x 53.3	ø = 70.9	176.0	8	< 0.08	< 0.08	66.0	> 40	C		219.7	100
TCUV 12 080	0.080	8	60.0 x 45.0	71.3 x 53.5	80.0 x 60.0	89.1 x 66.6	ø = 88.6	221.0	8	< 0.08	< 0.08	103.1	> 40	C		264.3	116
TCUV 23 036	0.241	11	19.9 x 14.9	23.7 x 17.8	26.6 x 19.9	29.6 x 22.1	35.3 x 29.4	98.7	8	< 0.1	< 0.08	11.4	> 40	C		160.4	61
TCUV 23 048	0.183	11	26.2 x 19.7	31.1 x 23.4	35.0 x 26.2	39.0 x 29.1	46.4 x 38.7	130.7	8	< 0.08	< 0.08	19.7	> 40	C		194.5	75
TCUV 23 056	0.157	11	30.6 x 22.9	36.3 x 27.3	40.8 x 30.6	45.4 x 33.9	54.1 x 45.2	154.0	8	< 0.1	< 0.08	26.8	> 40	C		216.8	80
TCUV 23 064	0.137	11	35.0 x 26.3	41.6 x 31.2	46.7 x 35.0	52.0 x 38.9	62.0 x 51.8	176.0	8	< 0.08	< 0.08	35.2	> 40	C		238.2	100
TCUV 23 080	0.110	11	43.6 x 32.7	51.8 x 38.9	58.2 x 43.6	64.8 x 48.5	77.3 x 64.5	221.0	8	< 0.08	< 0.08	54.5	> 40	C		283.0	116

1 Working distance: distance between the front lens 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 (higher wF#) can be supplied on request
3 Maximum slope of chief rays inside the lens: when converted to millirad, 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 very sharp image, only half of the nominal field depth should be considered.
6 Nominal value.
7 Measured from the front end of the mechanics to the camera flange.
8 With 1/1.8" (8.9 mm diagonal) detectors, the FOV of TCUV 12 XXX lenses may show some vignetting at the image corners, as these lenses are optimized for 1/2" detectors (8 mm diagonal).
9 For the fields with the indication "Ø =", the image of a circular object of such diameter is fully inscribed into the detector.
10 Indicates the availability of an integrated camera phase adjustment feature.

TCSM series

3D bi-telecentric lenses with Scheimpflug adjustment

KEY ADVANTAGES

Unique Scheimpflug adjustment
No other lens can perform oblique measurements.

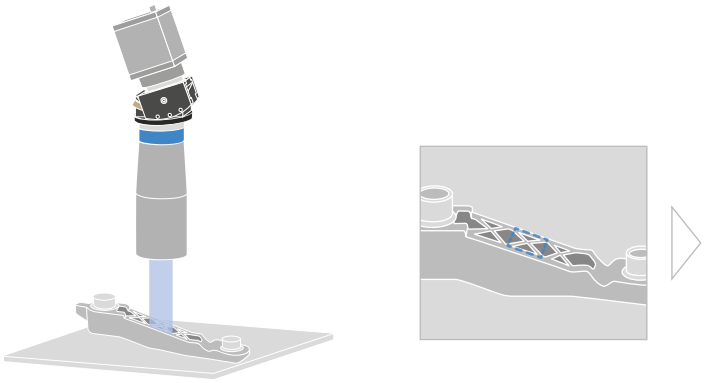
The image is radially undistorted
Linear extension can be perfectly calibrated.

Compatible with any C-mount camera
C-mount standard compliant.

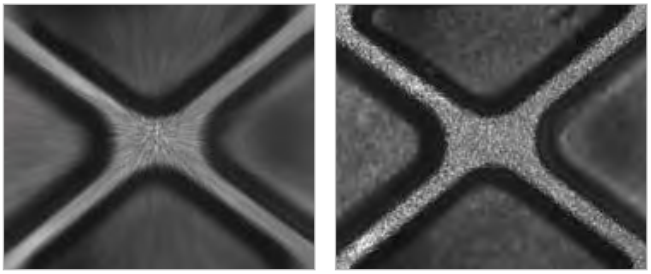
Detailed test report with measured optical parameters.

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 ranges 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

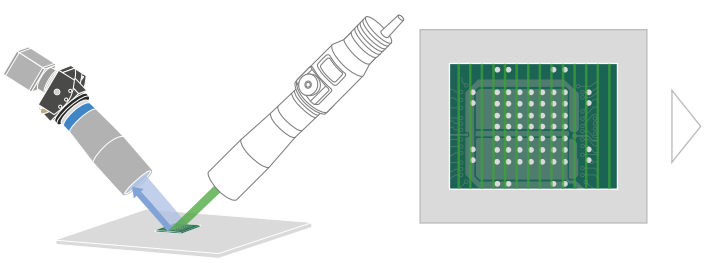


TCSM imaging and measuring sloped objects.

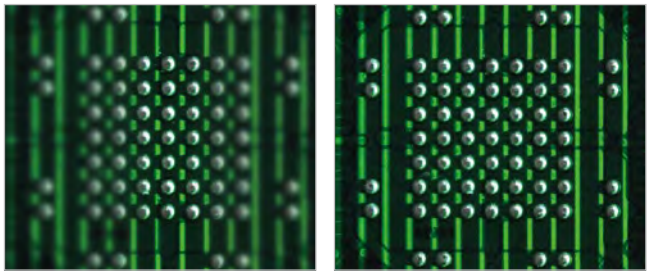


Without tilt adjustment, the object is not homogeneously focused.

At the Scheimpflug angle, the image becomes sharp.

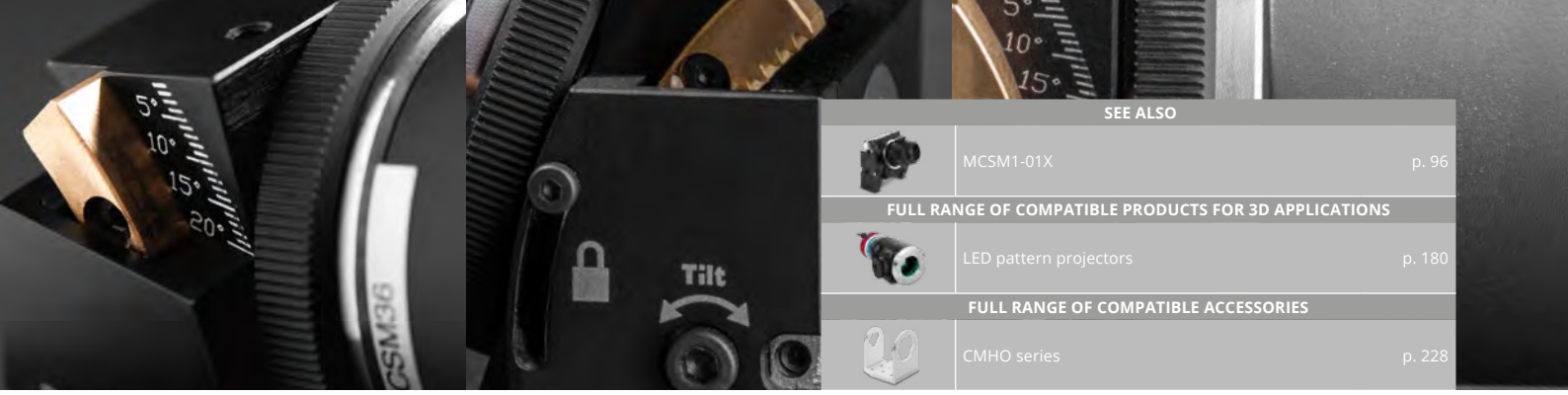


Scheimpflug telecentric lens and projector both at 45° relative to the object plane.



Without tilt adjustment, the object is not homogeneously focused.

At the Scheimpflug angle, the image becomes sharp.



SEE ALSO

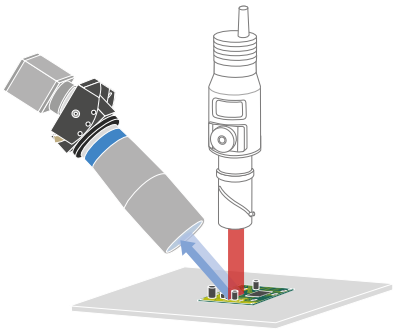
MCSM1-01X p. 96

FULL RANGE OF COMPATIBLE PRODUCTS FOR 3D APPLICATIONS

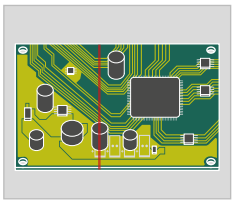
LED pattern projectors p. 180

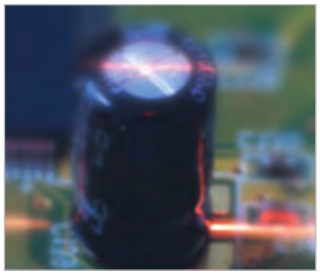
FULL RANGE OF COMPATIBLE ACCESSORIES

CMHO series p. 228

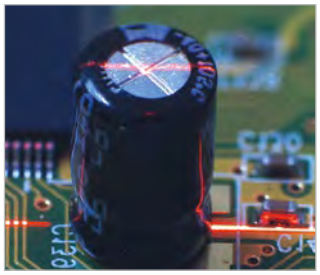


TCSM series lens at 45° and telecentric pattern projector at 90° relative to the object plane.





Without tilt adjustment, the object is not homogeneously focused.



At the Scheimpflug angle, the image becomes sharp.

Part number	Object tilt (deg)	Mount tilt (deg)	WD (mm) 1	Horizontal mag (x)	Vertical mag (x)	Mount	Phase adj. 2	Long detector side horizontal 1/3" w x h 4.80 x 3.60 (mm x mm)	Long detector side horizontal 1/2" w x h 6.40 x 4.80 (mm x mm)	Long detector side horizontal 2/3" w x h 8.50 x 7.09 (mm x mm)	Long detector side vertical 1/3" w x h 3.60 x 4.80 (mm x mm)	Long detector side vertical 1/2" w x h 4.80 x 6.40 (mm x mm)	Long detector side vertical 2/3" w x h 6.60 x 8.50 (mm x mm)
								Field of view - w x h (mm x mm)			Field of view - w x h (mm x mm)		
TCSM 016	0.0	0.0	43.1	0.528	0.528	C	Yes	9.09 x 6.82	12.1 x 9.09	16.1 x 13.4	6.82 x 9.09	9.09 x 12.1	13.4 x 16.1
	10.0	5.3		0.528	0.522			9.09 x 6.89	12.1 x 9.19	16.1 x 13.6	6.82 x 9.19	9.09 x 12.3	13.4 x 16.3
	20.0	10.9		0.528	0.505			9.09 x 7.13	12.1 x 9.50	16.1 x 14.0	6.82 x 9.50	9.09 x 12.7	13.4 x 16.8
	30.0	17.0		0.528	0.478			9.09 x 7.53	12.1 x 10.0	16.1 x 14.8	6.82 x 10.0	9.09 x 13.4	13.4 x 17.8
TCSM 024	0.0	0.0	67.2	0.350	0.350	C	Yes	13.7 x 10.3	18.3 x 13.7	24.3 x 20.3	10.3 x 13.7	13.7 x 18.3	20.3 x 24.3
	15.0	5.4		0.350	0.340			13.7 x 10.6	18.3 x 14.1	24.3 x 20.9	10.3 x 14.1	13.7 x 18.8	20.3 x 25.0
	30.0	11.4		0.350	0.309			13.7 x 11.6	18.3 x 15.5	24.3 x 22.9	10.3 x 15.5	13.7 x 20.7	20.3 x 27.5
	45.0	19.3		0.350	0.262			13.7 x 13.7	18.3 x 18.3	24.3 x 27.0	10.3 x 18.3	13.7 x 24.4	20.3 x 32.4
TCSM 036	0.0	0.0	102.5	0.243	0.243	C	Yes	19.7 x 14.8	26.3 x 19.7	34.9 x 29.1	14.8 x 19.7	19.7 x 26.3	29.1 x 34.9
	15.0	3.7		0.243	0.235			19.7 x 15.3	26.3 x 20.4	34.9 x 30.1	14.8 x 20.4	19.7 x 27.2	29.1 x 36.1
	30.0	8.0		0.243	0.213			19.7 x 16.9	26.3 x 22.6	34.9 x 33.3	14.8 x 22.6	19.7 x 30.1	29.1 x 40.0
	45.0	13.6		0.243	0.177			19.7 x 20.3	26.3 x 27.1	34.9 x 40.1	14.8 x 27.1	19.7 x 36.2	29.1 x 48.0
TCSM 048	0.0	0.0	132.9	0.185	0.185	C	Yes	26.0 x 19.5	34.7 x 26.0	46.0 x 38.4	19.5 x 26.0	26.0 x 34.7	38.4 x 46.0
	15.0	2.8		0.185	0.179			26.0 x 20.2	34.7 x 26.9	46.0 x 39.7	19.5 x 26.9	26.0 x 35.8	38.4 x 47.6
	30.0	6.1		0.185	0.161			26.0 x 22.4	34.7 x 29.8	46.0 x 44.1	19.5 x 29.8	26.0 x 39.8	38.4 x 52.8
	45.0	10.5		0.185	0.133			26.0 x 27.1	34.7 x 36.1	46.0 x 53.4	19.5 x 36.1	26.0 x 48.2	38.4 x 64.0
TCSM 056	0.0	0.0	157.8	0.157	0.157	C	Yes	30.6 x 22.9	40.8 x 30.6	54.1 x 45.2	22.9 x 30.6	30.6 x 40.8	45.2 x 54.1
	15.0	2.4		0.157	0.152			30.6 x 23.7	40.8 x 31.6	54.1 x 46.7	22.9 x 31.6	30.6 x 42.2	45.2 x 56.0
	30.0	5.1		0.157	0.137			30.6 x 26.4	40.8 x 35.2	54.1 x 51.9	22.9 x 35.2	30.6 x 46.9	45.2 x 62.3
	45.0	8.8		0.157	0.112			30.6 x 32.0	40.8 x 42.7	54.1 x 63.1	22.9 x 42.7	30.6 x 57.0	45.2 x 75.7
TCSM 064	0.0	0.0	181.8	0.137	0.137	C	Yes	34.9 x 26.2	46.6 x 34.9	61.8 x 51.6	26.2 x 34.9	34.9 x 46.6	51.6 x 61.8
	15.0	2.1		0.137	0.133			34.9 x 27.1	46.6 x 36.1	61.8 x 53.4	26.2 x 36.1	34.9 x 48.2	51.6 x 64.0
	30.0	4.5		0.137	0.119			34.9 x 30.1	46.6 x 40.2	61.8 x 59.4	26.2 x 40.2	34.9 x 53.6	51.6 x 71.2
	45.0	7.8		0.137	0.098			34.9 x 36.7	46.6 x 48.9	61.8 x 72.3	26.2 x 48.9	34.9 x 65.2	51.6 x 86.6
TCSM 080	0.0	0.0	226.7	0.110	0.110	C	Yes	43.6 x 32.7	58.2 x 43.6	77.3 x 64.5	32.7 x 43.6	43.6 x 58.2	64.5 x 77.3
	15.0	1.7		0.110	0.106			43.6 x 33.9	58.2 x 45.2	77.3 x 66.7	32.7 x 45.2	43.6 x 60.2	64.5 x 80.0
	30.0	3.6		0.110	0.095			43.6 x 37.7	58.2 x 50.3	77.3 x 74.3	32.7 x 50.3	43.6 x 67.0	64.5 x 89.0
	45.0	6.3		0.110	0.078			43.6 x 46.0	58.2 x 61.3	77.3 x 90.6	32.7 x 61.3	43.6 x 81.8	64.5 x 108.6
TCSM 096	0.0	0.0	278.6	0.093	0.093	C	Yes	51.4 x 38.5	68.5 x 51.4	91.0 x 75.9	38.5 x 51.4	51.4 x 68.5	75.9 x 91.0
	15.0	1.4		0.093	0.090			51.4 x 39.9	68.5 x 53.2	91.0 x 78.6	38.5 x 53.2	51.4 x 70.9	75.9 x 94.2
	30.0	3.1		0.093	0.081			51.4 x 44.4	68.5 x 59.3	91.0 x 87.5	38.5 x 59.3	51.4 x 79.0	75.9 x 104.9
	45.0	5.3		0.093	0.066			51.4 x 54.3	68.5 x 72.4	91.0 x 106.9	38.5 x 72.4	51.4 x 96.5	75.9 x 128.1

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 Indicates the availability of an integrated camera phase adjustment feature.

TCLWD series

Long working distance telecentric lenses for 2/3" detectors

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 and offer 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 have 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.

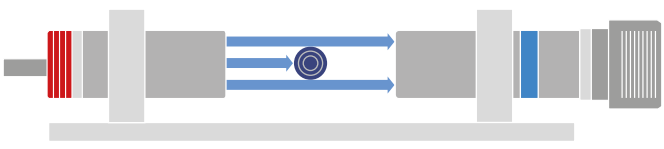
High numerical aperture
For small pixel size / high resolution detectors.

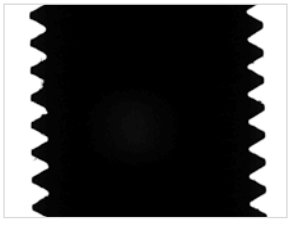
Easy rotational phase adjustment
Robust and precise tuning of the lens-camera phase.

Full range of compatible products
Fits LTCLHP telecentric illuminators, CMHO clamping supports and LTRN ring illuminators.

Detailed test report with measured optical parameters.

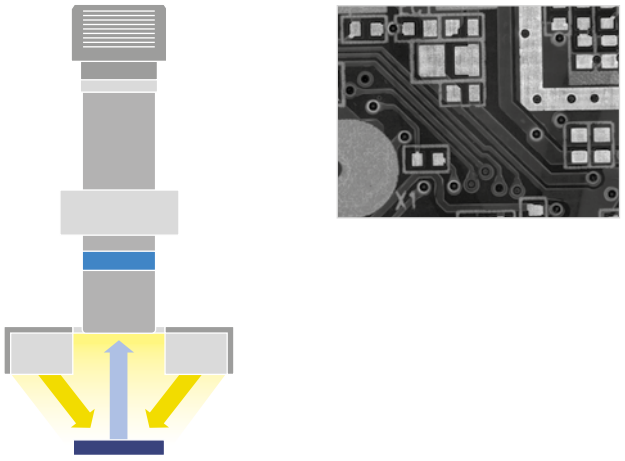
Application examples



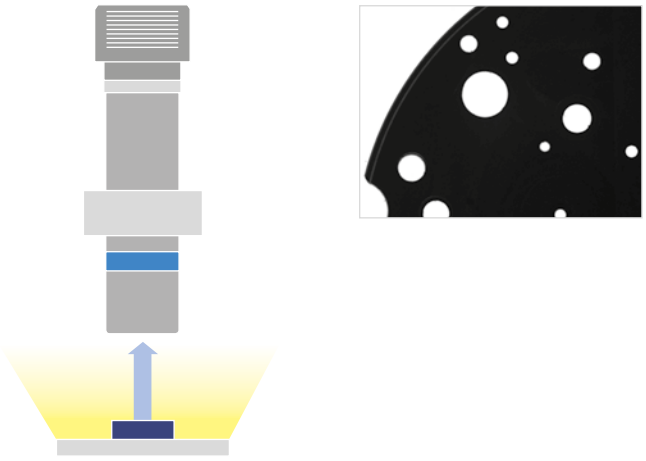


A TCLWD050 lens assembled with a CMHO016 clamping mechanics and back-illuminated by a LTCLHP016-G telecentric illuminator forming an inspection system for measurement of mechanical components such as milling tools and screws.

FOR OTHER LONG WORKING DISTANCE TELECENTRIC LENSES, SEE ALSO	
TCVLWD series	p. 46
FULL RANGE OF COMPATIBLE ILLUMINATORS	
Backlights LTBP, LTBC, LTBFC series	p. 164-170
COMPATIBLE CLAMPING MECHANICS	
Mounting clamp CMHO016	p. 228
FULL RANGE OF COMPATIBLE CAMERAS	
Area scan cameras	p. 196-205



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



A TCLWD lens measuring a clock gear with backlight illumination.

			Detector type					Optical specifications						Mechanical specs			
Part number	**Mag.** (x)	**Image circle** Ø (mm)	**1/3'' 6.0 mm diag w x h** 4.80 x 3.60 (mm x mm)	**1/2.5'' 7.1 mm diag w x h** 5.70 x 4.28 (mm x mm)	**1/2'' 8.0 mm diag w x h** 6.40 x 4.80 (mm x mm)	**1/1.8'' 8.9 mm diag w x h** 7.13 x 5.33 (mm x mm)	**2/3''- 5 Mpx 11.1 mm diag w x h** 8.50 x 7.09 (mm x mm)	**WD** (mm) **1**	**wF/#** **2**	**Telecentricity** typical (max) (deg) **3**	**Distortion** typical (max) (%) **4**	**Field depth** (mm) **5**	**CTF** @35lp/mm (%)	**Mount**	**Phase adj.** **7**	**Length** (mm) **6**	**Diam.** (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	17.0 x 14.2	132.3	12	< 0.04 (0.06)	< 0.1 (0.2)	4.0	> 60	C	Yes	131	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 8.08	12.9 x 10.7	132.3	12	< 0.04 (0.06)	< 0.1 (0.2)	2.3	> 58	C	Yes	149	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 7.11	11.3 x 9.45	132.3	12	< 0.04 (0.06)	< 0.1 (0.2)	1.8	> 55	C	Yes	155	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 5.33	8.50 x 7.09	132.3	12	< 0.04 (0.06)	< 0.05 (0.1)	1.0	> 60	C	Yes	126	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 3.55	5.67 x 4.73	132.3	16	< 0.04 (0.06)	< 0.05 (0.1)	0.6	> 50	C	Yes	140	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 2.13	3.40 x 2.84	132.3	20	< 0.04 (0.06)	< 0.05 (0.1)	0.3	> 40	C	Yes	157	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 1.52	2.43 x 2.03	132.3	24	< 0.04 (0.06)	< 0.05 (0.1)	0.2	> 30	C	Yes	175	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.
4 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.
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.
7 Indicates the availability of an integrated camera phase adjustment feature.

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 with built-in coaxial illumination

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 the semiconductor industry.

Easy rotational phase adjustment
Robust and precise tuning of the camera phase.

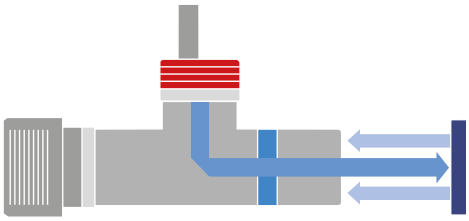
Detailed test report with measured optical parameters.

TCCX series is a range of lenses designed for measurement and defect detection on flat surfaces. They feature 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 detect small surface defects such as scratches or grooves, finding application in many industries, from the electronics and semiconductor industries to the glass and metal fabrication industries.
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 internal reflection issues of conventional coaxial illumination systems: this makes TCCX lenses the perfect choice especially when inspecting highly reflective flat surfaces (approx. > 30% reflectance).

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

FOR OTHER MAGNIFICATIONS COAXIAL TELECENTRIC LENSES SEE ALSO		
	TCCXQ series	p. 36
	TCCXHM, TCCXLM series	p. 47
FULL RANGE OF COMPATIBLE ILLUMINATORS		
	Backlights LTBP, LTBC, LTBFC series	p. 164-170
FULL RANGE OF COMPATIBLE ACCESSORIES		
	Mounting mechanics CMHO016	p. 228
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205

Application examples



TCCX lens inspects objects using coaxial illumination.

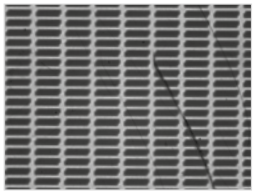
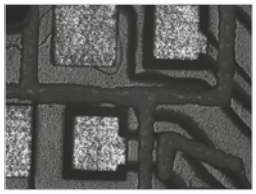


Image of an LCD display taken with a TCCX250 lens.



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

Scratches on a stainless steel surface emphasized by coaxial illumination.

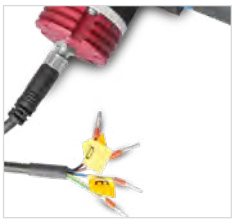
Note
In some cases, low magnification models (e.g. TCCX050-x, TCCX066-x, TCCX075-x) may generate hotspots, especially when imaging non-reflective objects.

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, the built-in electronics behaves as an open circuit allowing for direct control of the LED source.



Electrical specifications

	Light	Device power ratings				LED power ratings		
Part number	**Light color, wavelength peak**	**DC voltage**		**Power consumption**	**Max LED fwd current**	**Forward voltage**		**Max pulse current**
		min (V)	max (V)	(W)	(mA)	typ. (V)	max (V)	(mA)
		1			2	3		4
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 Tolerance ± 10%.
2 Used in continuous (not pulsed) mode.
3 At max forward current. Tolerance is ±0.06V on forward voltage measurements.
4 At pulse width <= 10 ms, duty cycle <= 10% condition.
Built-in electronics board must be bypassed (see tech info online).

			Detector type					Optical specifications						Mechanical specs			
Part number	**Mag.** (x)	**Image circle** Ø (mm)	**1/3'' 6.0 mm diag w x h** 4.80 x 3.60 (mm x mm)	**1/2.5'' 7.1 mm diag w x h** 5.70 x 4.28 (mm x mm)	**1/2'' 8.0 mm diag w x h** 6.40 x 4.80 (mm x mm)	**1/1.8'' 8.9 mm diag w x h** 7.13 x 5.33 (mm x mm)	**2/3"- 5 Mpx 11.1 mm diag w x h** 8.50 x 7.09 (mm x mm)	**WD** (mm) 1	**wF/#** 2	**Telecentricity** typical (max) (deg) 3	**Distortion** typical (max) (%) 4	**Field depth** (mm) 5	**CTF** @35lp/mm (%)	**Mount**	**Phase adj.** 7	**Length** (mm) 6	**Diam.** (mm)
			Object field of view (mm x mm)														
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	17.0 x 14.2	132.3	12	< 0.04 (0.06)	< 0.1 (0.2)	4.0	> 60	C	Yes	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	17.0 x 14.2	132.3	12	< 0.04 (0.06)	< 0.1 (0.2)	4.0	> 60	C	Yes	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 8.08	12.9 x 10.7	132.3	12	< 0.04 (0.06)	< 0.1 (0.2)	2.3	> 58	C	Yes	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 8.08	12.9 x 10.7	132.3	12	< 0.04 (0.06)	< 0.1 (0.2)	2.3	> 58	C	Yes	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 7.11	11.3 x 9.45	132.3	12	< 0.04 (0.06)	< 0.1 (0.2)	1.8	> 55	C	Yes	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 7.11	11.3 x 9.45	132.3	12	< 0.04 (0.06)	< 0.1 (0.2)	1.8	> 55	C	Yes	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 5.33	8.50 x 7.09	132.3	12	< 0.04 (0.06)	< 0.05 (0.1)	1.0	> 60	C	Yes	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 5.33	8.50 x 7.09	132.3	12	< 0.04 (0.06)	< 0.05 (0.1)	1.0	> 60	C	Yes	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 3.55	5.67 x 4.73	132.3	16	< 0.04 (0.06)	< 0.05 (0.1)	0.6	> 50	C	Yes	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 3.55	5.67 x 4.73	132.3	16	< 0.04 (0.06)	< 0.05 (0.1)	0.6	> 50	C	Yes	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 2.13	3.40 x 2.84	132.3	20	< 0.04 (0.06)	< 0.05 (0.1)	0.3	> 40	C	Yes	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 2.13	3.40 x 2.84	132.3	20	< 0.04 (0.06)	< 0.05 (0.1)	0.3	> 40	C	Yes	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 1.52	2.43 x 2.03	132.3	24	< 0.04 (0.06)	< 0.05 (0.1)	0.2	> 30	C	Yes	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 1.52	2.43 x 2.03	132.3	24	< 0.04 (0.06)	< 0.05 (0.1)	0.2	> 30	C	Yes	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 (higher wF#) 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.
4 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.
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.
7 Indicates the availability of an integrated camera phase adjustment feature.

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 assemblies with coaxial illumination

TCCXQ optical assemblies combine the high optical performance 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 straylight and back-reflections, while marking superior optical performance (in terms of resolution, telecentricity and distortion) even at the highest magnifications.

This optical layout also minimizes the overall height of the system, also allowing the user to easily adjust the camera orientation and back focal distance of the lens.

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

KEY ADVANTAGES

Completely free from stray-light
Compatible with both reflective and diffusive surface objects.

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.

Detailed test report with measured optical parameters.

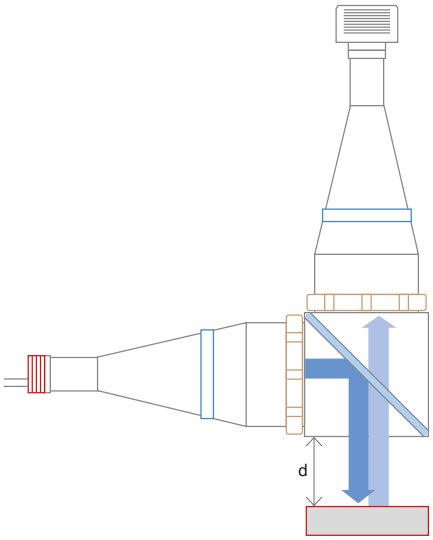
TCCXQ 066-G, formed by TCLWD 066, CMBS 016, LTCLHP 016-G.

FOR OTHER COAXIAL SOLUTIONS SEE ALSO		
	TCCX series	p. 34
	LTCXC series	p. 179
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205

Electrical specifications

	Light	Device power ratings				LED power ratings		
Part number	**Light color, wavelength peak**	**DC voltage**		**Power consumption**	**Max LED fwd current**	**Forward voltage**		**Max pulse current**
		min	max			typ.	max	
		(V)	(V)	(W)	(mA)	(V)	(V)	(mA)
		1			2	3		4
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 Tolerance ± 10%.
2 Used in continuous (not pulsed) mode.
3 At max forward current. Tolerance is ±0.06V on forward voltage measurements.
4 At pulse width <= 10 ms, duty cycle <= 10% condition.
Built-in electronics board must be bypassed (see tech info online).



TCCXQ 011-x

			Available colours		Detector type					Optical specifications	Mechanical specifications			
Part number (*)	**Mag.** (x)	**Image circle** Ø (mm)	**G**	**W**	**1/3" 6.0 mm diag w x h** 4.80 x 3.60 (mm x mm)	**1/2.5" 7.1 mm diag w x h** 5.70 x 4.28 (mm x mm)	**1/2" 8.0 mm diag w x h** 6.40 x 4.80 (mm x mm)	**1/1.8" 8.9 mm diag w x h** 7.13 x 5.33 (mm x mm)	**2/3" - 5 Mpx 11.1 mm diag w x h** 8.50 x 7.09 (mm x mm)	**Object distance** d (mm)	**Mount**	**Phase adj.** 1	**Length** (mm)	**Height** (mm)	**Width** (mm)
					Object field of view (mm x mm)									
TCCXQ 150-x	1.50	11	x	x	3.20 x 2.40	3.80 x 2.85	4.27 x 3.20	4.75 x 3.55	5.67 x 4.73	82.8	C		155.0	64	198.9
TCCXQ 100-x	1.00	11	x	x	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	8.50 x 7.09	82.8	C		155.0	64	182.5
TCCXQ 075-x	0.75	11	x	x	6.40 x 4.80	7.60 x 5.71	8.53 x 6.40	9.51 x 7.11	11.3 x 9.45	82.8	C		155.0	64	213.5
TCCXQ 066-x	0.66	11	x	x	7.27 x 5.45	8.64 x 6.48	9.70 x 7.27	10.8 x 8.08	12.9 x 10.7	82.8	C		155.0	64	207.8
TCCXQ 050-x	0.50	11	x	x	9.60 x 7.20	11.4 x 8.56	12.8 x 9.60	14.3 x 10.7	17.0 x 14.2	82.8	C		155.0	64	189.2
TCCXQ 024-x	0.24	11	x	x	19.8 x 14.8	23.5 x 17.6	26.3 x 19.8	29.3 x 22.9	35.0 x 29.2	20.1	C		235.9	88	252.4
TCCXQ 018-x	0.18	11	x	x	26.1 x 19.6	31.0 x 23.3	34.8 x 26.1	38.8 x 29.0	46.2 x 38.5	37.0	C		285.2	102	303.2
TCCXQ 016-x	0.16	11	x	x	30.6 x 22.9	36.3 x 27.3	40.8 x 30.6	45.4 x 33.9	54.1 x 45.2	50.7	C		319.2	108	336.7
TCCXQ 014-x	0.14	11	x	x	34.8 x 26.1	41.3 x 31.0	46.4 x 34.8	51.7 x 38.6	61.6 x 51.4	63.8	C		350.3	128	367.6
TCCXQ 011-x	0.11	11	x	x	43.6 x 32.7	51.8 x 38.9	58.2 x 43.6	64.8 x 48.5	77.3 x 64.5	90.1	C		415.6	144	433.1

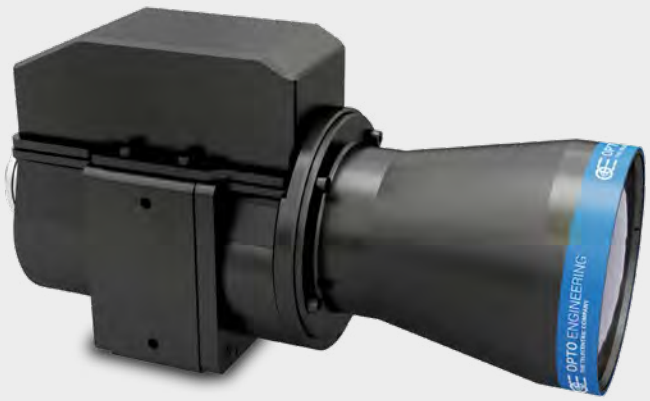
1 Indicates the availability of an integrated camera phase adjustment feature.
If missing, it can be supplied upon request.

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

TCZRS series

8x bi-telecentric zoom lenses with motorized control

NEW



KEY ADVANTAGES

Perfect magnification constancy and parfocality
No need to re-calibrate or refocus after zooming thanks to an extremely precise positioning system.

Bi-telecentricity
For very accurate measurement.

Excellent image center stability
Image centering is maintained at every magnification.

Full motorization control
Zoom magnification is set via software.

Fast and silent operations
Max 2 seconds to quietly switch from one mag to another.

Detailed test report with measured optical parameters.

TCZRS 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.

An upgraded version of TCZR lenses, the newly designed TCZRS lenses feature an extremely precise positioning system with a bipolar stepper motor and an incremental magnetic encoder, delivering exceptional magnification repeatability. Moreover, focusing and image centering stability are guaranteed at every magnification position, thus avoiding recalibration at any given time.
Four different magnifications, featuring a total zoom range of 8x, can be selected through a dedicated remote control software.

Bi-telecentricity, high resolution and low distortion make these zoom lenses able to perform the same measurement tasks as classic telecentric lenses.

FULL RANGE OF COMPATIBLE ILLUMINATORS		
	Backlights LT2BC, LTBP, LTBC, LTBFC series	p. 162-170
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205

Product combinations*

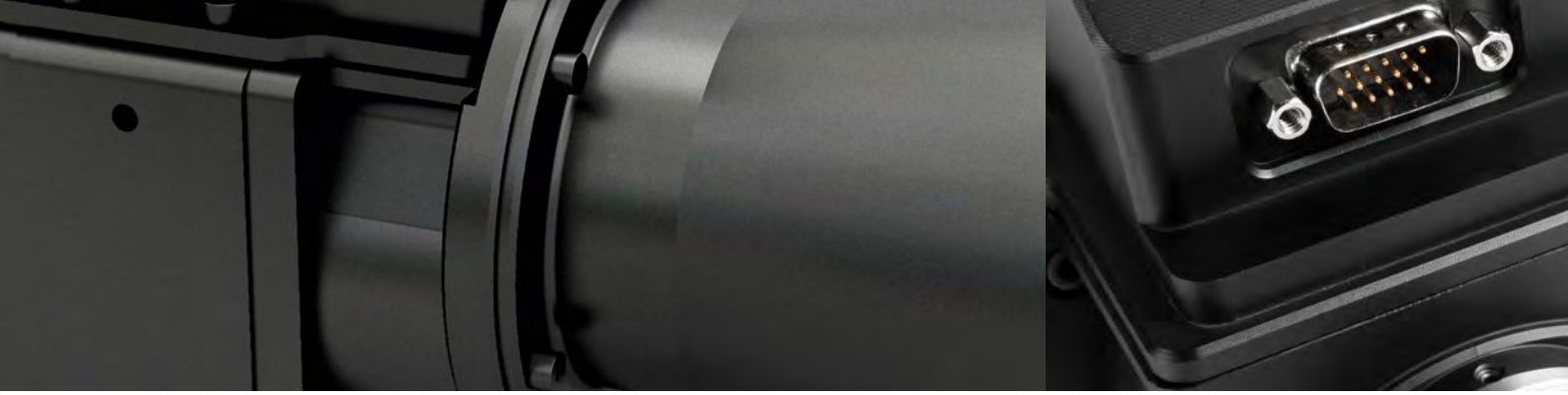
TCZRS + CBMT002 + MTDV1CH-22A2

* To be ordered separately

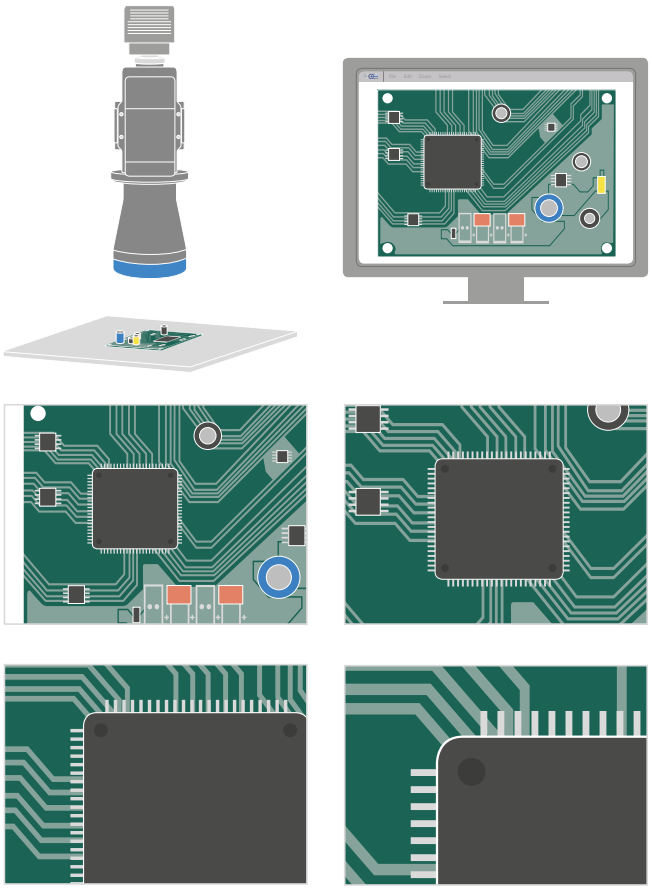
MANUAL AND SETUP

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

www.opto-e.com



Application examples



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

Multiple lens surfaces can be used for direct mounting without clamps, thanks to the M6 threaded holes located on 3 sides.

			Detector type					Optical specifications						Mechanical specs				
Part number	Mag. (x)	Image circle Ø (mm)	1/3" 6.0 mm diag w x h 4.80 x 3.60 (mm x mm)	1/2.5" 7.1 mm diag w x h 5.70 x 4.28 (mm x mm)	1/2" 8.0 mm diag w x h 6.40 x 4.80 (mm x mm)	1/1.8" 8.9 mm diag w x h 7.13 x 5.33 (mm x mm)	2/3"- 5 Mpx 11.1 mm diag w x h 8.50 x 7.09 (mm x mm)	WD (mm)	wF/# 1	Telecentricity (deg) 2	Distortion (%)	Field depth (mm) 3	CTF @70lp/mm (%)	Mount	Phase adj. 4	Length (mm)	Max height (mm)	Max width (mm)
			Object field of view (mm x mm)															
TCZR 036S	0.250	11.0	19.2 x 14.4	22.8 x 17.1	25.6 x 19.2	28.5 x 21.3	34.0 x 28.4	74.0	16	< 0.05	< 0.05	13.2	> 40	C	Yes	212.0	144	103
	0.500		9.60 x 7.20	11.4 x 8.56	12.8 x 9.60	14.3 x 10.7	17.0 x 14.2				< 0.04	3.3	> 35					
	1.000		4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	8.50 x 7.09				< 0.04	0.8	> 40					
	2.000		2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.57 x 2.67	4.25 x 3.55				< 0.08	0.2	> 35					
TCZR 072S	0.125	11.0	38.4 x 28.8	45.6 x 34.2	51.2 x 38.4	57.0 x 42.6	68.0 x 56.7	157.8	16	< 0.05	< 0.10	53.0	> 35	C	Yes	279.7	144	103
	0.250		19.2 x 14.4	22.8 x 17.1	25.6 x 19.2	28.5 x 21.3	34.0 x 28.4				< 0.08	13.2	> 40					
	0.500		9.60 x 7.20	11.4 x 8.56	12.8 x 9.60	14.3 x 10.7	17.0 x 14.2				< 0.05	3.3	> 40					
	1.000		4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	8.50 x 7.09				< 0.07	0.8	> 35					

1 Working F-number (wF/#): the real F-number of a lens when used as a macro. Lenses with smaller apertures (higher wF#) can be supplied on request.
2 Maximum slope of principal rays inside the lens: when converted to millirad, it gives the maximum measurement error for any millimiter of object displacement.
3 At the borders of the field depth the image can be still used for measurement but, to get a very sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 3.45 µm.
4 Indicates the availability of an integrated camera phase adjustment feature.

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

Tested system
The bench is quality tested as a whole system.

Detailed test report with measured optical parameters.

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 PTTC chrome-on-glass calibration pattern
- 1 CMPH pattern holder

The benches come ready for use, 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 such as distortion, telecentricity and resolution. For this reason these benches feature unmatched image resolution and field depth.

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

NEW

TCBENCH series is now also available with new LTSCHP1W-GZ **green** light source, suitable for any kind of sample and specifically tailored for measuring reflective objects and objects with sharp edges.

KEY FEATURES

- **Reduction of edge diffraction effects**
- Enhanced **illumination uniformity**, especially on large FOVs
- Less sensitive to **alignment**

Ordering information

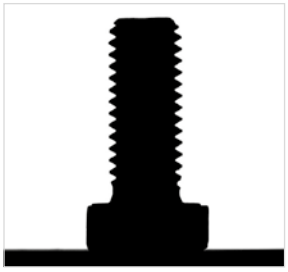
To order a telecentric light with a new green light source, use p/n **TCBENCH0xx-0-GZ** (i.e. TCBENCH064-0-GZ).

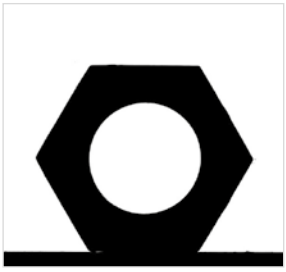
FULL RANGE OF COMPATIBLE ACCESSORIES

Optical filters p. 242

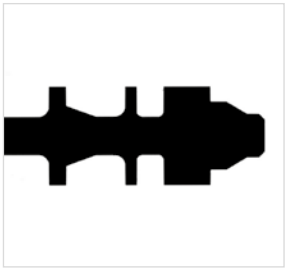
FULL RANGE OF COMPATIBLE CAMERAS

Area scan cameras p. 196-205

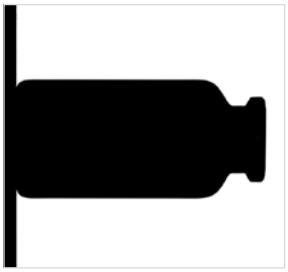


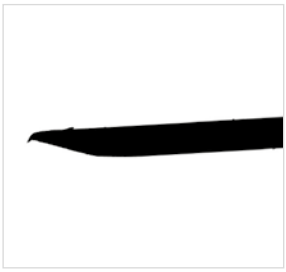


Mechanical

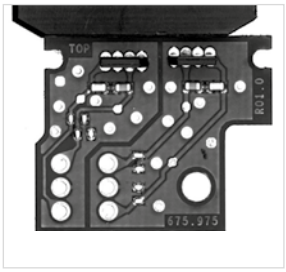


Automotive





Glass & pharma



Electronics

			Detector type					Optical specifications							Mechanical specifications				
Part number	Mag.	Image circle	1/3" 6.0 mm diag w x h 4.80 x 3.60 (mm x mm)	1/2.5" 7.1 mm diag w x h 5.70 x 4.28 (mm x mm)	1/2" 8.0 mm diag w x h 6.40 x 4.80 (mm x mm)	1/1.8" 8.9 mm diag w x h 7.13 x 5.33 (mm x mm)	2/3"- 5 Mpx 11.1 mm diag w x h 8.50 x 7.09 (mm x mm)	Light color peak wavelength	WD (mm) 1	wF/#	Optical Accuracy (µm) 2	Optical Accuracy (%) 3	Field Depth (mm) 4	CTF @70lp/mm (%)	Mount	Phase adj. 5	Length (mm)	Width (mm)	Height (mm)
	(x)	Ø (mm)	Field of view (mm x mm)																
TCBENCH 009	1.000	11.0	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	8.50 x 7.09	green, 520 nm	62.2	11	< 5	< 0.06%	0.9	> 35	C		292.0	56.0	78.5
TCBENCH 016	0.528	11.0	9.09 x 6.82	10.80 x 8.11	12.1 x 9.09	13.5 x 10.1	16.1 x 13.4	green, 520 nm	43.1	8	< 8	< 0.05%	2.4	> 40	C		315.0	65.5	81.2
TCBENCH 024	0.350	11.0	13.7 x 10.3	16.3 x 12.2	18.3 x 13.7	20.4 x 15.2	24.3 x 20.3	green, 520 nm	67.2	8	< 13	< 0.05%	5.4	> 55	C		393.0	65.5	78.5
TCBENCH 036	0.243	11.0	19.8 x 14.8	23.5 x 17.6	26.3 x 19.8	29.3 x 21.9	35.0 x 29.2	green, 520 nm	102.5	8	< 22	< 0.06%	11.2	> 50	C		549.0	103.0	140.5
TCBENCH 048	0.184	11.0	26.1 x 19.6	31.0 x 23.3	34.8 x 26.1	38.8 x 29.0	46.2 x 38.5	green, 520 nm	132.9	8	< 31	< 0.06%	19.5	> 50	C		657.0	117.0	147.5
TCBENCH 056	0.157	11.0	30.6 x 22.9	36.3 x 27.3	40.8 x 30.6	45.4 x 33.9	54.1 x 45.2	green, 520 nm	157.8	8	< 36	< 0.06%	26.8	> 55	C		715.0	122.0	150
TCBENCH 064	0.138	11.0	34.8 x 26.1	41.3 x 31.0	46.4 x 34.8	51.7 x 38.6	61.6 x 51.4	green, 520 nm	181.8	8	< 40	< 0.06%	34.7	> 65	C		848.0	143.0	160.5
TCBENCH 080	0.110	11.0	43.6 x 32.7	51.8 x 38.9	58.2 x 43.6	64.8 x 48.5	77.3 x 64.5	green, 520 nm	226.7	8	< 55	< 0.07%	54.5	> 55	C		936.0	158.0	168
TCBENCH 096	0.093	11.0	51.6 x 38.7	61.3 x 46.0	68.8 x 51.6	76.7 x 57.3	91.4 x 76.2	green, 520 nm	278.6	8	< 70	< 0.07%	76.3	> 50	C		1087.0	206.5	185

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

2,3 Maximum measurement error without software calibration; standard image correction libraries yield close to zero measurement error.

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

5 Indicates the availability of an integrated camera phase adjustment feature. If missing, it can be supplied upon request (except for TCBENCH009).

TCBENCH CORE series

Ultra compact TCCORE optical benches for precision measurements

Vision Systems Design 2016 Innovators Awards GOLD

inVISION TOP INNOVATION 2016

INTERNATIONAL PATENT PENDING

KEY ADVANTAGES

Multi-level cost cutting
Saves money on manufacturing and transportation costs.

Downsized vision system
Allows you to reduce the length of your measurement system.

Pre-assembled setup
Just add a camera and measurement software and you're ready to go.

Best optical performance in a super tight space
A complete optical system designed for hassle free development of demanding precision measurement applications.

Detailed test report with measured optical parameters.

TCBENCH CORE series are complete and super compact optical systems offering superior performance for highly demanding measurement applications in a super compact assembly.

The benches come pre-mounted and pre-aligned, ensuring the best accuracy that a telecentric measurement system can deliver.

Each TCBENCH CORE integrates:
- 1 TC CORE bi-telecentric lens for 2/3" sensors
- 1 LTCLHP CORE telecentric illuminator (green)
- 1 CMPTCR base plate

TCBENCH CORE systems deliver the same optical performance as our TCBENCH systems in a very reduced space.

FULL RANGE OF COMPATIBLE ACCESSORIES		
	LTDV1CH-17V strobe controller	p. 256
	Optical filters	p. 242
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205

NEW

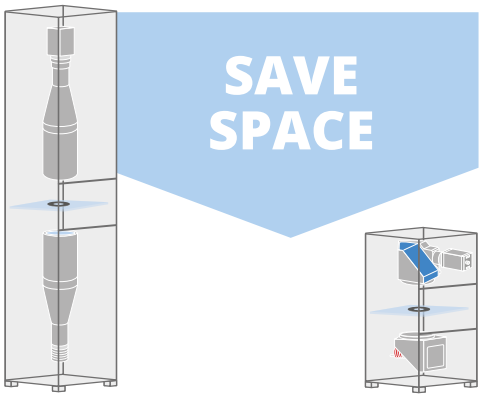
TCBENCH CORE series is now also available with new LTSCHP1W-GZ **green** light source, suitable for any kind of sample and specifically tailored for measuring reflective objects and objects with sharp edges.

KEY FEATURES

- **Reduction of edge diffraction effects**
- Enhanced **illumination uniformity**, especially on large FOVs
- Less sensitive to **alignment**

Ordering information

To order a telecentric light with a new green light source, use p/n **TCCRBENCH0xx-0-GZ** (i.e. TCCRBENCH064-0-GZ).



Example of off-line measurement systems with “classic“ telecentric lens and illuminator (left) and TCBENCH CORE (right).

ADVANTAGES

Save more

- Lower manufacturing cost due to less material employed
- Less space required for storage and use
- Lower shipment expenses due to smaller size
- Lower transportation risks

Sell more

- A smaller vision system or measurement machine is preferred by the industry

Application example:

Setup example:
2/3” sensor camera mounted on a bi-telecentric CORE lens TCCR23048, coupled with a LTCLCR048-G telecentric CORE illuminator and a robot holder clamp CMHORBCR048.

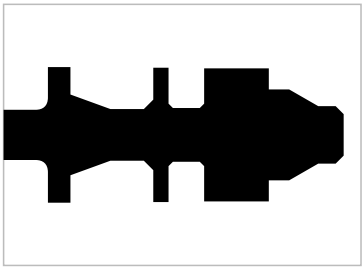


Image of the shaft presents very sharp edges and no reflections, allowing precise 2D measurement.

Technical information:

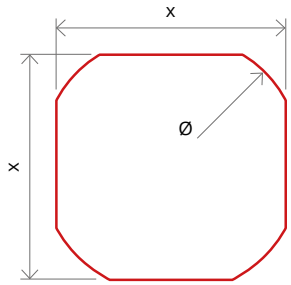


Image shape dimensions (Ø, x).

Non-contact measurement machine example

Technical specs		Standard components	TCBENCH CORE	Comparison
Camera sensor	(mm)	8.50 x 7.09	8.50 x 7.09	
FOV	(mm)	91.4 x 72.6	91.4 x 72.6	High-end performance of both systems
Field depth	(mm)	94	94	
CTF 70 lp/mm	(%)	> 50	> 50	
Height	(m)	1.65	0.77	54% volume difference
Length	(m)	0.45	0.45	
Width	(m)	0.41	0.41	
Volume	(m^3)	0.30	0.14	

			Detector type					Optical specs					Mechanical specifications				
Part number	**Mag.** (x)	**Image shape dimensions** Ø,x (mm) 4	**1/3” 6.0 mm diag w x h** 4.80 x 3.60 (mm x mm)	**1/2.5” 7.1 mm diag w x h** 5.70 x 4.28 (mm x mm)	**1/2” 8.0 mm diag w x h** 6.40 x 4.80 (mm x mm)	**1/1.8” 8.9 mm diag w x h** 7.13 x 5.33 (mm x mm)	**2/3” - 5 Mpx 11.1 mm diag w x h** 8.50 x 7.09 (mm x mm)	**WD** (mm) 1	**wF/#**	**Optical accuracy** (µm)	**Field Depth** (mm) 2	**CTF** @70lp/mm (%)	**Mount**	**Phase adj.** 3	**Length** (mm)	**Width** (mm)	**Height** (mm)
			Field of view (mm x mm)														
TCCRBENCH 048	0.184	Ø=11.0, x=9.6	26.1 x 19.6	31.0 x 23.3	34.8 x 26.1	38.8 x 29.0	46.2 x 38.5	132.9	8	< 31	19.5	> 50	C	Yes	352	134	118
TCCRBENCH 056	0.157	Ø=11.1, x=9.6	30.6 x 22.9	36.3 x 27.3	40.8 x 30.6	45.4 x 33.9	54.1 x 45.2	157.8	8	< 36	26.8	> 55	C	Yes	424	144	122
TCCRBENCH 064	0.138	Ø=11.5, x=9.5	34.8 x 26.1	41.3 x 31.0	46.4 x 34.8	51.7 x 38.6	61.6 x 51.4	181.8	8	< 40	34.7	> 65	C	Yes	474	152	134
TCCRBENCH 080	0.110	Ø=11.1, x=9.6	43.6 x 32.7	51.8 x 38.9	58.2 x 43.6	64.8 x 48.5	77.3 x 64.5	226.7	8	< 55	54.5	> 55	C	Yes	578	182	162
TCCRBENCH 096	0.093	Ø=11.4, x=9.4	51.6 x 38.7	61.3 x 46.0	68.8 x 51.6	76.7 x 57.3	91.4 x 76.2	278.6	8	< 70	76.3	> 50	C	Yes	696	200	189

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

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. Pixel size used for calculation is 5.5 µm.

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

4 Indicates the dimensions and shape of image, where “Ø =” stands for diameter and “x=” indicates the nominal image height and length (Tech Info for related drawing).

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 buying this kit for your laboratory and discover the advantages of bi-telecentric optics!

Part number	Products included	Description
TCKIT	TC 23 064	Bi-telecentric lens for 2/3", 64 x 48 mm FOV
	TC 23 036	Bi-telecentric lens for 2/3", 36 x 27 mm FOV
	TC 23 016	Bi-telecentric lens for 2/3", 16 x 12 mm FOV
	TC 23 009	Bi-telecentric lens for 2/3", 8.8 x 6.6 mm FOV
	LTCLHP 036-G	Telecentric HP illuminator, beam diameter 45 mm, green

FULL RANGE OF COMPATIBLE ACCESSORIES		
	CMHO series clamping mechanics	p. 228
	LTDV1CH-17V strobe controller	p. 256
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205

NEW

TCKIT case is now also available with new LTSCHP1W-GZ **green** light source, suitable for any kind of sample and specifically tailored for measuring reflective objects and objects with sharp edges.

KEY FEATURES

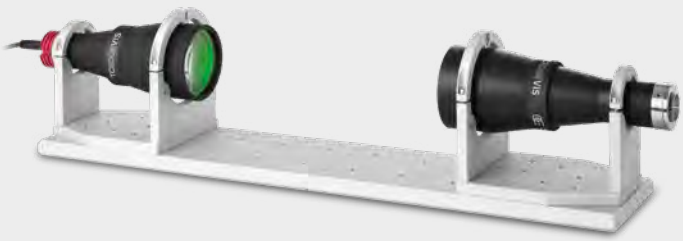
- **Reduction of edge diffraction effects**
- Enhanced **illumination uniformity**, especially on large FOVs
- Less sensitive to **alignment**

Ordering information

To order a telecentric light with a new green light source, use p/n **TCKIT-0-GZ**.

TCEDGEVIS

Telecentric system for defect detection on flat transparent materials

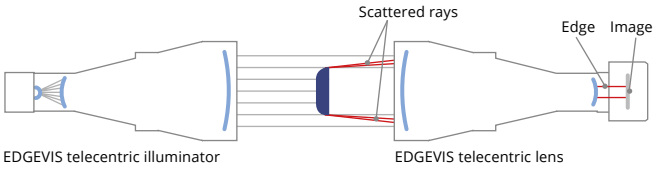


KEY ADVANTAGES

Revolutionary method for inspecting flat transparent surfaces (clear glass, plastic films) and for OCR/OCV applications:

- **Extreme contrast**
- **Even the smallest defects can be seen**
- **Supplied as a ready-to-use optical bench**

TCEDGEVIS telecentric optical systems provide a truly revolutionary approach to the inspection of flat transparent materials.
The special optical design ensures that only the light rays deflected by an object's edge are imaged on the sensor: edges are automatically extracted without the need of software algorithms. This technique allows the detection of extremely tiny defects, particles and surface discontinuities that would be impossible to see with traditional lens systems. This approach is also suitable for OCR/OCV applications on clear glass, plastic films etc.
TCEDGEVIS optical systems include an EDGE telecentric lens, EDGE telecentric illuminator and mounting mechanics and are supplied as fully tested and pre-aligned optical benches.

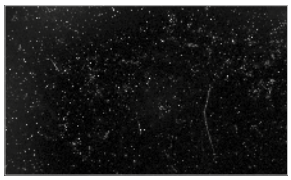


Working principle: when light rays encounter an object they get scattered from its edges. The TCEDGEVIS optical system filters these rays to form an image of the object's profile with much higher contrast than traditional optical methods.

Display inspection:

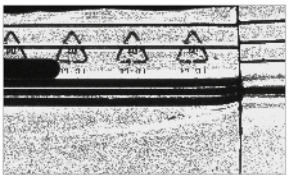
Detection of tiny scratches, bubbles and inclusions on smartphone glass screen.

Particle analysis:



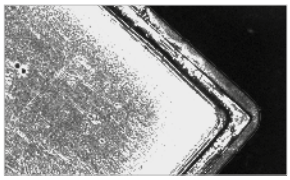
Checking dust deposits on a glass surface.

Packaging:



Seal integrity inspection at the highest contrast.

Packaging:



Seal quality inspection on transparent plastics and soldering joint.

OCR and OCV:

Transparent text on clear plastic surface.

			Detector type					Optical specifications		Mechanical specifications				
			1/3" 6.0 mm diag	1/2.5" 7.1 mm diag	1/2" 8.0 mm diag	1/1.8" 8.9 mm diag	2/3" - 5 Mpx 11.1 mm diag		Light color,					
Part number	**Mag.**	**Image circle**	**w x h**	**w x h**	**w x h**	**w x h**	**w x h**	**WD**	**peak wavelength**	**Mount**	**Phase adj.**	**Length**	**Width**	**Height**
	(x)	Ø (mm)	4.80 x 3.60 (mm x mm)	5.70 x 4.28 (mm x mm)	6.40 x 4.80 (mm x mm)	7.13 x 5.33 (mm x mm)	8.50 x 7.09 (mm x mm)	(mm)	(nm)			(mm)	(mm)	(mm)
			Object field of view (mm x mm)					1			2			
TCEV 23 036-G	0.243	11.0	19.8 x 14.8	23.5 x 17.6	26.3 x 19.8	29.3 x 21.9	35.0 x 29.2	102.5	green, 520	C	No	549	103.0	140.5
TCEV 23 048-G	0.184	11.0	26.1 x 19.6	31.0 x 23.3	34.8 x 26.1	38.8 x 29.0	46.2 x 38.5	132.9	green, 520	C	Yes	657	117.0	147.5
TCEV 23 056-G	0.157	11.0	30.6 x 22.9	36.3 x 27.3	40.8 x 30.6	45.4 x 33.9	54.1 x 45.2	157.8	green, 520	C	Yes	715	122.0	150.0
TCEV 23 064-G	0.138	11.0	34.8 x 26.1	41.3 x 31.0	46.4 x 34.8	51.7 x 38.6	61.6 x 51.4	181.8	green, 520	C	Yes	848	143.0	160.5
TCEV 23 080-G	0.110	11.0	43.6 x 32.7	51.8 x 38.9	58.2 x 43.6	64.8 x 48.5	77.3 x 64.5	226.7	green, 520	C	Yes	936	158.0	168.0
TCEV 23 096-G	0.093	11.0	51.6 x 38.7	61.3 x 46.0	68.8 x 51.6	76.7 x 57.3	91.4 x 76.2	278.6	green, 520	C	Yes	1087	206.5	185.0

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

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

TCHM series

High magnification telecentric lenses for detectors up to 2/3"

*RT

Part number	Mag.	Image circle	Max detector size	Detector type: 1/3" 6.0 mm diag w x h 4.80 x 3.60	1/2.5" 7.1 mm diag w x h 5.70 x 4.28	1/2" 8.0 mm diag w x h 6.40 x 4.80	1/1.8" 8.9 mm diag w x h 7.13 x 5.33	2/3"- 5 MP 11.1 mm diag w x h 8.50 x 7.09	Optical specifications: WD	wF/# [1]	Distortion	Field depth	Nominal resolving power	Mechanical specs: Mount	Phase adj. [2]	Length	Diam.
	(x)	Ø (mm)		(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm)	(mm)		(%)	(mm)	(µm)			(mm)	(mm)
				Object field of view (mm x mm)													
Working distance (WD) 71 mm																	
RT-HR-6M-71	6.00	11	2/3"	0.80 x 0.60	0.95 x 0.71	1.07 x 0.80	1.19 x 0.89	1.42 x 1.18	71	41.1	0.27	0.10	4.6	C	Yes	107.9	18
RT-HR-4M-71	4.00	11	2/3"	1.20 x 0.90	1.43 x 1.07	1.60 x 1.20	1.78 x 1.33	2.13 x 1.77	71	29.0	0.24	0.13	4.9	C	Yes	100.0	18
RT-HR-2M-71	2.00	11	2/3"	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.57 x 2.67	4.25 x 3.55	71	18.5	0.21	0.30	6.2	C	Yes	97.0	18
RT-HR-1M-71	1.00	11	2/3"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	8.50 x 7.09	71	15.6	0	0.90	10.5	C	Yes	116.1	18
Working distance (WD) 110 mm																	
RT-HR-6M-110	6.00	11	2/3"	0.80 x 0.60	0.95 x 0.71	1.07 x 0.80	1.19 x 0.89	1.42 x 1.18	110	55.6	0.25	0.16	6.2	C	Yes	114.2	18
RT-HR-4M-110	4.00	11	2/3"	1.20 x 0.90	1.43 x 1.07	1.60 x 1.20	1.78 x 1.33	2.13 x 1.77	110	39.2	0.54	0.20	6.6	C	Yes	94.6	18
RT-HR-2M-110	2.00	11	2/3"	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.57 x 2.67	4.25 x 3.55	110	23.8	0.78	0.40	8.0	C	Yes	87.4	18
RT-HR-1M-110	1.00	11	2/3"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	8.50 x 7.09	110	6.7	0.04	1.00	11.2	C	Yes	125.2	18

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

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

FULL RANGE OF COMPATIBLE ILLUMINATORS

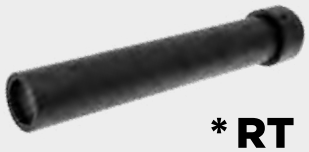
LTRNDC series LED direct ringlights p. 156

FULL RANGE OF COMPATIBLE CAMERAS

Area scan cameras p. 196-205

TCVLWD series

Very long working distance (WD) telecentric lenses for detectors up to 1/1.8"



*RT

Part number	Mag.	Image circle	Max detector size	Detector type: 1/3" 6.0 mm diag w x h 4.80 x 3.60	1/2.5" 7.1 mm diag w x h 5.70 x 4.28	1/2" 8.0 mm diag w x h 6.40 x 4.80	1/1.8" 8.9 mm diag w x h 7.13 x 5.33	Optical specifications: WD	wF/# [1]	Distortion	Field depth	Nominal resolving power	Mechanical specs: Mount	Phase adj. [2]	Length	Diam.
	(x)	Ø (mm)		(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm)		(%)	(mm)	(µm)			(mm)	(mm)
				Object field of view (mm x mm)												
RT-TV-1M-150	1.00	8.0	1/2"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	-	156.0	16.7	0.15	1.00	12.0	C	Yes	159.0	24
RT-TV-2M-150	2.00	8.0	1/2"	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	-	156.0	25.0	0.07	0.44	9.0	C	Yes	168.0	24
RT-TV-3M-150	3.00	8.0	1/2"	1.60 x 1.20	1.90 x 1.43	2.13 x 1.60	-	156.0	37.5	0.05	0.34	9.0	C	Yes	171.8	24
RT-TV-1M-220	1.00	8.0	1/2"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	-	218.2	20.0	0.10	1.24	14.0	C	Yes	218.0	27
RT-TV-2M-220	2.00	8.0	1/2"	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	-	218.2	33.0	0.10	0.67	11.0	C	Yes	227.0	27
RT-TV-3M-220	3.00	8.0	1/2"	1.60 x 1.20	1.90 x 1.43	2.13 x 1.60	-	218.2	43.0	0.10	0.41	9.6	C	Yes	230.8	27
RT-TV-1M-290	1.00	8.0	1/2"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	-	290.7	20.0	0.10	1.24	13.0	C	Yes	203.7	27
RT-TV-2M-290	2.00	8.0	1/2"	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	-	290.7	33.0	0.10	0.67	11.0	C	Yes	212.7	27
RT-TV-3M-290	3.00	8.0	1/2"	1.60 x 1.20	1.90 x 1.43	2.13 x 1.60	-	290.7	43.0	0.10	0.41	9.6	C	Yes	216.5	27
RT-TV-05M-400	0.50	8.0	1/2"	9.60 x 7.20	11.40 x 8.56	12.80 x 9.60	-	400.0	13.9	0.35	3.07	18.6	C	Yes	149.6	34
RT-TV-1M-400	1.00	8.9	1/1.8"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	400.0	25.0	0.30	1.69	16.8	C	Yes	166.2	34
RT-TV-2M-400	2.00	8.9	1/1.8"	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.57 x 2.67	400.0	33.3	0.07	0.64	11.2	C	Yes	176.5	34
RT-TV-05M-800	0.50	8.9	1/1.8"	9.60 x 7.20	11.4 x 8.56	12.8 x 9.60	14.3 x 10.7	800.0	16.7	0.04	3.89	22.4	C	Yes	279.6	58
RT-TV-1M-800	1.00	8.9	1/1.8"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	800.0	20.0	0.09	1.24	13.4	C	Yes	296.7	58

1 Working F-number (wF/#): the real F-number of a lens when used as a macro.
2 Indicates the availability of an integrated camera phase adjustment feature.

FULL RANGE OF COMPATIBLE CAMERAS

Area scan cameras p. 196-205

TCCXHM series

High magnification telecentric lenses with built-in coaxial illumination for detectors up to 2/3"

*RT

Part number	Mag.	Image circle	Max detector size	Detector type: 1/3'' 6.0 mm diag w x h 4.80 x 3.60 (mm x mm)	1/2.5'' 7.1 mm diag w x h 5.70 x 4.28 (mm x mm)	1/2" 8.0 mm diag w x h 6.40 x 4.80 (mm x mm)	1/1.8" 8.9 mm diag w x h 7.13 x 5.33 (mm x mm)	2/3"- 5 MP 11.1 mm diag w x h 8.50 x 7.09 (mm)	Optical specifications: WD	wF/# 1	Distortion	Field depth	Nominal resolving power	Mechanical specs: Mount	Phase adj. 2	Length	Diam.
	(x)	Ø (mm)		Object field of view (mm x mm)					(mm)		(%)	(mm)	(µm)			(mm)	(mm)
Working distance (WD) 71 mm																	
RT-HR-6F-71	6.00	11	2/3"	0.80 x 0.60	0.95 x 0.71	1.07 x 0.80	1.19 x 0.89	1.42 x 1.18	71.00	41.1	0.27	0.10	4.60	C	Yes	107.9	18
RT-HR-4F-71	4.00	11	2/3"	1.20 x 0.90	1.43 x 1.07	1.60 x 1.20	1.78 x 1.33	2.13 x 1.77	71.00	29.0	0.24	0.13	4.90	C	Yes	100.0	18
RT-HR-2F-71	2.00	11	2/3"	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.57 x 2.67	4.25 x 3.55	71.00	18.5	0.21	0.30	6.20	C	Yes	97.0	18
RT-HR-1F-71	1.00	11	2/3"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	8.50 x 7.09	71.00	15.6	0	0.90	10.50	C	Yes	116.1	18
Working distance (WD) 110 mm																	
RT-HR-6F-110	6.00	11	2/3"	0.80 x 0.60	0.95 x 0.71	1.07 x 0.80	1.19 x 0.89	1.42 x 1.18	110.00	55.6	0.25	0.16	6.20	C	Yes	114.2	18
RT-HR-4F-110	4.00	11	2/3"	1.20 x 0.90	1.43 x 1.07	1.60 x 1.20	1.78 x 1.33	2.13 x 1.77	110.00	39.2	0.54	0.20	6.60	C	Yes	94.6	18
RT-HR-2F-110	2.00	11	2/3"	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.57 x 2.67	4.25 x 3.55	110.00	23.8	0.78	0.40	8.00	C	Yes	87.4	18
RT-HR-1F-110	1.00	11	2/3"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	8.50 x 7.09	110.00	6.7	0.04	1.00	11.20	C	Yes	125.2	18

1 Working F-number (wF/#): the real F-number of a lens when used as a macro.
2 Indicates the availability of an integrated camera phase adjustment feature.

FULL RANGE OF COMPATIBLE LED SOURCES

LDSC series p. 267

FULL RANGE OF COMPATIBLE CAMERAS

Area scan cameras p. 196-205

TCCXLM series

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

*RT

Part number	Mag.	Image circle	Max detector size	Detector type: 1/3'' 6.0 mm diag w x h 4.80 x 3.60 (mm x mm)	1/2.5'' 7.1 mm diag w x h 5.70 x 4.28 (mm x mm)	1/2" 8.0 mm diag w x h 6.40 x 4.80 (mm x mm)	1/1.8" 8.9 mm diag w x h 7.13 x 5.33 (mm x mm)	2/3"- 5 MP 11.1 mm diag w x h 8.50 x 7.09 (mm)	Optical specifications: WD	wF/# 1	Distortion	Field depth	Nominal resolving power	Mechanical specs: Mount	Phase adj. 2	Length	Diam.
	(x)	Ø (mm)		Object field of view (mm x mm)					(mm)		(%)	(mm)	(µm)			(mm)	(mm)
RT-TCL0400-F	0.40	11	2/3"	12.0 x 9.00	14.3 x 10.7	16.0 x 12.0	17.8 x 13.3	21.3 x 17.7	78.50	8 - 40	-0.015	2.10	15.00	C		188	44
RT-TCL0300-F	0.30	11	2/3"	16.0 x 12.0	19.0 x 14.3	21.3 x 16.0	23.8 x 17.8	28.3 x 23.6	108.20	8 - 40	0.010	3.70	20.00	C		224	49
RT-TCL0200-F	0.20	11	2/3"	24.0 x 18.0	28.5 x 21.4	32.0 x 24.0	35.7 x 26.7	42.5 x 35.5	167.00	8 40	0.010	8.40	31.00	C		297	68

1 Working F-number (wF/#): the real F-number of a lens when used as a macro.
2 Indicates the availability of an integrated camera phase adjustment feature.

FULL RANGE OF COMPATIBLE LED SOURCES

LDSC series p. 267

FULL RANGE OF COMPATIBLE CAMERAS

Area scan cameras p. 196-205

TC1MHR-TC4MHR series

High-resolution telecentric lenses for large detectors up to 4/3"

NEW MODELS

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.

TC1MHR-TC4MHR series are high resolution telecentric lenses designed for detectors larger than 2/3", making them the perfect choice for advanced metrology applications.
The TC1MHR-TC4MHR series delivers unmatched resolution, low distortion and homogeneous image quality while offering the best performance to price ratio.

TC1MHR-TC4MHR feature a compact and robust design that allows for easy integration in industrial environments. Additionally, the camera phase can be easily adjusted 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.

TC1MHR series for up to 1/1.2" sensors

			Detector type					Optical specifications						Mechanical specifications			
			1/1.2" IMX174 / IMX249 13.3 mm diag	1" IMX255 / IMX267 16.1 mm diag	1.1" IMX253 / IMX304 17.6 mm diag	1.2" KAI-4022 / 4021 21.5 mm diag	4/3" KAI-08050 22.6 mm diag										
Part number	Mag.	Image circle	w x h 11.3 x 7.10	w x h 14.19 x 7.51	w x h 14.2 x 10.4	w x h 15.2 x 15.2	w x h 18.1 x 13.6	WD	wF/#	Telecentricity typical (max)	Distortion typical (max)	Field depth	CTF @50lp/mm	Mount	Phase adj	Length	Diam.
	(x)	Ø (mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm) 7	(mm) 1	2	(deg) 3	(%) 4	(mm) 5	(%)		9	(mm) 6	(mm)
			Object field of view (mm x mm) 8														
TC1MHR 016-C	0.639	13.3	17.68 x 11.11	ø = 11.75	ø = 16.28	ø = 20.81	ø = 20.81	44.3	11	<0.08 (0.10)	<0.08 (0.10)	2.2	> 40	C	Yes	125.4	40
TC1MHR 024-C	0.424	13.3	26.65 x 16.75	ø = 17.71	ø = 24.53	ø = 31.37	ø = 31.37	67.2	11	<0.08 (0.10)	<0.08 (0.10)	5.0	> 45	C	Yes	150.2	44
TC1MHR 036-C	0.295	13.3	38.31 x 24.07	ø = 25.46	ø = 35.25	ø = 45.08	ø = 45.08	102.6	11	<0.08 (0.10)	<0.08 (0.10)	10.4	> 40	C	Yes	177.6	61
TC1MHR 048-C	0.222	13.3	50.90 x 31.98	ø = 33.83	ø = 46.85	ø = 59.91	ø = 59.91	132.4	8	<0.08 (0.10)	<0.08 (0.10)	13.4	> 55	C	Yes	215.9	75
TC1MHR 056-C	0.190	13.3	59.47 x 37.37	ø = 39.53	ø = 54.74	ø = 70.00	ø = 70.00	157.8	8	<0.08 (0.10)	<0.08 (0.10)	18.3	> 55	C	Yes	238.7	80
TC1MHR 064-C	0.166	13.3	68.07 x 42.77	ø = 45.24	ø = 62.65	ø = 80.12	ø = 80.12	181.9	8	<0.08 (0.10)	<0.08 (0.10)	24.0	> 55	C	Yes	259.8	100
TC1MHR 080-C	0.134	13.3	84.33 x 52.99	ø = 56.04	ø = 77.61	ø = 99.25	ø = 99.25	226.8	8	<0.08 (0.10)	<0.08 (0.10)	36.8	> 50	C	Yes	305.4	116
TC1MHR 096-C	0.114	13.3	99.12 x 62.28	ø = 65.88	ø = 91.23	ø = 116.67	ø = 116.67	278.6	8	<0.08 (0.10)	<0.08 (0.10)	50.8	> 55	C	Yes	342.7	143
TC1MHR 120-C	0.087	13.3	129.89 x 81.61	ø = 86.32	ø = 119.54	ø = 152.87	ø = 152.87	334.6	8	<0.08 (0.10)	<0.08 (0.10)	87.2	> 55	C	Yes	428.3	180
TC1MHR 144-C	0.074	13.3	152.70 x 95.95	ø = 101.49	ø = 140.54	ø = 179.73	ø = 179.73	396.0	8	<0.08 (0.10)	<0.08 (0.10)	120.5	> 55	C	Yes	487.8	200
TC1MHR 192-C	0.056	13.3	201.79 x 126.79	ø = 134.11	ø = 185.71	ø = 237.50	ø = 237.50	527.6	8	<0.08 (0.10)	<0.08 (0.10)	210.5	> 50	C	Yes	628.2	260
TC1MHR 240-C	0.045	13.3	251.1 x 157.8	ø = 166.89	ø = 231.11	ø = 295.56	ø = 295.56	492.9	8	<0.08 (0.10)	<0.08 (0.10)	325.9	> 55	C	Yes	788.4	322

TC2MHR series for up to 1" sensors

			Detector type					Optical specifications						Mechanical specifications			
			1/1.2" IMX174 / IMX249 13.3 mm diag	1" IMX255 / IMX267 16.1 mm diag	1.1" IMX253 / IMX304 17.6 mm diag	1.2" KAI-4022 / 4021 21.5 mm diag	4/3" KAI-08050 22.6 mm diag										
Part number	Mag. (x)	Image circle Ø (mm)	w x h 11.3 x 7.10 (mm x mm)	w x h 14.19 x 7.51 (mm x mm)	w x h 14.2 x 10.4 (mm x mm)	w x h 15.2 x 15.2 (mm x mm)	w x h 18.1 x 13.6 (mm x mm) 7	WD (mm) 1	wF/# 2	Telecentricity typical (max) (deg) 3	Distortion typical (max) (%) 4	Field depth (mm) 5	CTF @50lp/mm (%)	Mount	Phase adj 9	Length (mm) 6	Diam. (mm)
			Object field of view (mm x mm) 8														
TC2MHR 016-C	0.767	16.6	14.73 x 9.26	18.50 x 9.79	ø = 13.56	ø = 19.82	ø = 17.73	43.8	16	<0.08 (0.10)	<0.04 (0.10)	2.2	> 30	C	Yes	145.5	45
TC2MHR 016-F	0.767	16.6	14.73 x 9.26	18.50 x 9.79	ø = 13.56	ø = 19.82	ø = 17.73	43.8	16	<0.08 (0.10)	<0.04 (0.10)	2.2	> 30	F	Yes	116.5	64
TC2MHR 016-E	0.767	16.6	14.73 x 9.26	18.50 x 9.79	ø = 13.56	ø = 19.82	ø = 17.73	43.8	16	<0.08 (0.10)	<0.04 (0.10)	2.2	> 30	M42X1 FD16	Yes	147.0	52
TC2MHR 024-C	0.508	16.9	22.24 x 13.98	27.93 x 14.78	ø = 20.47	ø = 29.92	ø = 26.77	67.2	16	<0.08 (0.10)	<0.04 (0.10)	5.1	> 40	C	Yes	170.4	45
TC2MHR 024-F	0.508	16.9	22.24 x 13.98	27.93 x 14.78	ø = 20.47	ø = 29.92	ø = 26.77	67.2	16	<0.08 (0.10)	<0.04 (0.10)	5.1	> 40	F	Yes	141.4	64
TC2MHR 024-E	0.508	16.9	22.24 x 13.98	27.93 x 14.78	ø = 20.47	ø = 29.92	ø = 26.77	67.2	16	<0.08 (0.10)	<0.04 (0.10)	5.1	> 40	M42X1 FD16	Yes	171.9	52
TC2MHR 036-C	0.353	16.7	32.01 x 20.11	40.20 x 21.27	ø = 29.46	ø = 43.06	ø = 38.53	102.6	16	<0.08 (0.10)	<0.08 (0.10)	10.6	> 30	C	Yes	197.7	61
TC2MHR 036-F	0.353	16.7	32.01 x 20.11	40.20 x 21.27	ø = 29.46	ø = 43.06	ø = 38.53	102.6	16	<0.08 (0.10)	<0.08 (0.10)	10.6	> 30	F	Yes	168.7	64
TC2MHR 036-E	0.353	16.7	32.01 x 20.11	40.20 x 21.27	ø = 29.46	ø = 43.06	ø = 38.53	102.6	16	<0.08 (0.10)	<0.08 (0.10)	10.6	> 30	M42X1 FD16	Yes	199.2	61
TC2MHR 048-C	0.268	16.9	42.16 x 26.49	52.95 x 28.02	ø = 38.81	ø = 56.72	ø = 50.75	133.4	16	<0.08 (0.10)	<0.08 (0.10)	18.4	> 30	C	Yes	232.8	75
TC2MHR 048-F	0.268	16.9	42.16 x 26.49	52.95 x 28.02	ø = 38.81	ø = 56.72	ø = 50.75	133.4	16	<0.08 (0.10)	<0.08 (0.10)	18.4	> 30	F	Yes	203.8	75
TC2MHR 048-E	0.268	16.9	42.16 x 26.49	52.95 x 28.02	ø = 38.81	ø = 56.72	ø = 50.75	133.4	16	<0.08 (0.10)	<0.08 (0.10)	18.4	> 30	M42X1 FD16	Yes	234.3	75
TC2MHR 056-C	0.228	16.8	49.56 x 31.14	62.24 x 32.94	ø = 45.61	ø = 66.67	ø = 59.65	157.8	16	<0.04 (0.08)	<0.05 (0.10)	25.4	> 40	C	Yes	257.1	80
TC2MHR 056-F	0.228	16.8	49.56 x 31.14	62.24 x 32.94	ø = 45.61	ø = 66.67	ø = 59.65	157.8	16	<0.04 (0.08)	<0.05 (0.10)	25.4	> 40	F	Yes	228.1	80
TC2MHR 056-E	0.228	16.8	49.56 x 31.14	62.24 x 32.94	ø = 45.61	ø = 66.67	ø = 59.65	157.8	16	<0.04 (0.08)	<0.05 (0.10)	25.4	> 40	M42X1 FD16	Yes	258.7	80
TC2MHR 064-C	0.200	16.8	56.50 x 35.50	70.95 x 37.55	ø = 52.00	ø = 76.00	ø = 68.00	181.9	16	<0.04 (0.08)	<0.05 (0.10)	33.0	> 40	C	Yes	278.3	100
TC2MHR 064-F	0.200	16.8	56.50 x 35.50	70.95 x 37.55	ø = 52.00	ø = 76.00	ø = 68.00	181.9	16	<0.04 (0.08)	<0.05 (0.10)	33.0	> 40	F	Yes	249.3	100
TC2MHR 064-E	0.200	16.8	56.50 x 35.50	70.95 x 37.55	ø = 52.00	ø = 76.00	ø = 68.00	181.9	16	<0.04 (0.08)	<0.05 (0.10)	33.0	> 40	M42X1 FD16	Yes	279.8	100
TC2MHR 080-C	0.160	16.9	70.63 x 44.38	88.69 x 46.94	ø = 65.00	ø = 95.00	ø = 85.00	226.8	16	<0.04 (0.08)	<0.05 (0.10)	51.6	> 40	C	Yes	324.0	116
TC2MHR 080-F	0.160	16.9	70.63 x 44.38	88.69 x 46.94	ø = 65.00	ø = 95.00	ø = 85.00	226.8	16	<0.04 (0.08)	<0.05 (0.10)	51.6	> 40	F	Yes	295.0	116
TC2MHR 080-E	0.160	16.9	70.63 x 44.38	88.69 x 46.94	ø = 65.00	ø = 95.00	ø = 85.00	226.8	16	<0.04 (0.08)	<0.05 (0.10)	51.6	> 40	M42X1 FD16	Yes	325.5	116
TC2MHR 096-C	0.137	16.9	82.48 x 51.82	103.58 x 54.82	ø = 75.91	ø = 110.95	ø = 99.27	278.6	16	<0.05 (0.10)	<0.07 (0.10)	70.3	> 40	C	Yes	396.4	143
TC2MHR 096-F	0.137	16.9	82.48 x 51.82	103.58 x 54.82	ø = 75.91	ø = 110.95	ø = 99.27	278.6	16	<0.05 (0.10)	<0.07 (0.10)	70.3	> 40	F	Yes	367.4	143
TC2MHR 096-E	0.137	16.9	82.48 x 51.82	103.58 x 54.82	ø = 75.91	ø = 110.95	ø = 99.27	278.6	16	<0.05 (0.10)	<0.07 (0.10)	70.3	> 40	M42X1 FD16	Yes	397.9	143
TC2MHR 120-C	0.104	16.5	108.65 x 68.27	136.44 x 72.21	ø = 100.00	ø = 146.15	ø = 130.77	334.6	16	<0.07(0.10)	<0.07 (0.10)	122.0	> 40	C	Yes	451.4	180
TC2MHR120-F	0.104	16.5	108.65 x 68.27	136.44 x 72.21	ø = 100.00	ø = 146.15	ø = 130.77	334.6	16	<0.07(0.10)	<0.07 (0.10)	122.0	> 40	F	Yes	422.4	180
TC2MHR 120-E	0.104	16.5	108.65 x 68.27	136.44 x 72.21	ø = 100.00	ø = 146.15	ø = 130.77	334.6	16	<0.07(0.10)	<0.07 (0.10)	122.0	> 40	M42X1 FD16	Yes	452.9	180
TC2MHR 144-C	0.089	16.8	126.97 x 79.78	159.44 x 84.38	ø = 116.85	ø = 170.79	ø = 152.81	396.0	16	<0.05 (0.10)	<0.05 (0.10)	166.6	> 40	C	Yes	510.8	200
TC2MHR 144-F	0.089	16.8	126.97 x 79.78	159.44 x 84.38	ø = 116.85	ø = 170.79	ø = 152.81	396.0	16	<0.05 (0.10)	<0.05 (0.10)	166.6	> 40	F	Yes	481.8	200
TC2MHR 144-E	0.089	16.8	126.97 x 79.78	159.44 x 84.38	ø = 116.85	ø = 170.79	ø = 152.81	396.0	16	<0.05 (0.10)	<0.05 (0.10)	166.6	> 40	M42X1 FD16	Yes	512.4	200
TC2MHR 192-C	0.067	16.8	168.66 x 105.97	211.79 x 112.09	ø = 155.22	ø = 226.87	ø = 202.99	527.5	16	<0.05 (0.10)	<0.04 (0.10)	294.1	> 40	C	Yes	649.2	260
TC2MHR 192-F	0.067	16.8	168.66 x 105.97	211.79 x 112.09	ø = 155.22	ø = 226.87	ø = 202.99	527.5	16	<0.05 (0.10)	<0.04 (0.10)	294.1	> 40	F	Yes	620.2	260
TC2MHR 192-E	0.067	16.8	168.66 x 105.97	211.79 x 112.09	ø = 155.22	ø = 226.87	ø = 202.99	527.5	16	<0.05 (0.10)	<0.04 (0.10)	294.1	> 40	M42X1 FD16	Yes	650.8	260
TC2MHR 240-C	0.053	16.2	213.21 x 133.96	267.74 x 141.70	ø = 196.23	ø = 286.79	ø = 256.60	492.9	16	<0.05 (0.10)	<0.04 (0.10)	469.9	> 40	C	Yes	812.2	322
TC2MHR 240-F	0.053	16.2	213.21 x 133.96	267.74 x 141.70	ø = 196.23	ø = 286.79	ø = 256.60	492.9	16	<0.05 (0.10)	<0.04 (0.10)	469.9	> 40	F	Yes	783.2	322
TC2MHR 240-E	0.053	16.2	213.21 x 133.96	267.74 x 141.70	ø = 196.23	ø = 286.79	ø = 256.60	492.9	16	<0.05 (0.10)	<0.04 (0.10)	469.9	> 40	M42X1 FD16	Yes	813.7	322

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 (higher wF#) 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..
7 With KAI-08050 (22.6 mm diagonal) detectors, the FOV of TC4MHRyyy-x lenses may show some vignetting at the image corners
8 For the fields with the indication "Ø =", the image of a circular object of such diameter is fully inscribed into the detector.
9 Indicates the availability of an integrated camera phase adjustment feature.

Ordering information

It's easy to select the right lens for your application: our part numbers are coded as **TC1MHR yyy-x**, **TC2MHR yyy-x**, **TC3MHR 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.

TC1MHR-TC4MHR series

High-resolution telecentric lenses for large detectors up to 4/3"

Mount C

Mount E = M42x1

Mount F

FOR COAXIAL TELECENTRIC LENSES UP TO 1" DETECTORS SEE ALSO

TCCX2M series p. 62

FULL RANGE OF COMPATIBLE ILLUMINATORS

LTCLHP series p. 132

FULL RANGE OF COMPATIBLE ACCESSORIES

CMMR series p. 236

FULL RANGE OF COMPATIBLE CAMERAS

Area scan cameras p. 196-205

TC3MHR series for up to 1.1" sensors

			Detector type					Optical specifications							Mechanical specifications			
			1/1.2" IMX174 / IMX249 13.3 mm diag	1" IMX255 / IMX267 16.1 mm diag	1.1" IMX253 / IMX304 17.6 mm diag	1.2" KAI-4022 / 4021 21.5 mm diag	4/3" KAI-08050 22.6 mm diag											
Part number	Mag. (x)	Image circle Ø (mm)	w x h 11.3 x 7.10 (mm x mm)	w x h 14.19 x 7.51 (mm x mm)	w x h 14.2 x 10.4 (mm x mm)	w x h 15.2 x 15.2 (mm x mm)	w x h 18.1 x 13.6 (mm x mm) 7	WD (mm) 1	wF/# 2	Telecentricity typical (max) (deg) 3	Distortion typical (max) (%) 4	Field depth (mm) 5	CTF @50lp/mm (%)	Mount	Phase adj 9	Length (mm) 6	Diam. (mm)
			Object field of view (mm x mm) 8															
TC3MHR 016-C	0.850	17.6	13.29 x 8.35	16.69 x 8.84	16.71 x 12.24	ø = 17.88	ø = 16.00	43.1	11	<0.08 (0.10)	<0.08 (0.10)	1.3	> 30	C	Yes	155.2	40
TC3MHR 024-C	0.564	17.6	20.04 x 12.59	25.16 x 13.32	25.18 x 18.44	ø = 26.95	ø = 24.11	67.2	11	<0.08 (0.10)	<0.08 (0.10)	2.9	> 40	C	Yes	177.0	44
TC3MHR 036-C	0.392	17.6	28.83 x 18.11	36.20 x 19.16	36.22 x 26.53	ø = 38.78	ø = 34.69	102.6	11	<0.08 (0.10)	<0.08 (0.10)	5.9	> 40	C	Yes	204.4	61
TC3MHR 048-C	0.303	17.6	37.29 x 23.43	46.83 x 24.79	46.86 x 34.32	ø = 50.17	ø = 44.88	132.9	8	<0.08 (0.10)	<0.08 (0.10)	7.2	> 50	C	Yes	223.4	75
TC3MHR 056-C	0.259	17.6	43.63 x 27.41	54.79 x 29.00	54.83 x 40.15	ø = 58.69	ø = 52.51	157.8	8	<0.08 (0.10)	<0.08 (0.10)	9.8	> 55	C	Yes	246.7	80
TC3MHR 064-C	0.227	17.6	49.78 x 31.28	62.51 x 33.08	62.56 x 45.81	ø = 66.96	ø = 59.91	181.9	8	<0.08 (0.10)	<0.08 (0.10)	12.8	> 55	C	Yes	284.0	100
TC3MHR 080-C	0.182	17.6	62.09 x 39.01	77.97 x 41.26	78.02 x 57.14	ø = 83.52	ø = 74.73	226.8	8	<0.08 (0.10)	<0.08 (0.10)	19.9	> 50	C	Yes	392.6	116
TC3MHR 096-C	0.153	17.6	73.86 x 46.41	92.75 x 49.08	92.81 x 67.97	ø = 99.35	ø = 88.89	278.6	8	<0.08 (0.10)	<0.08 (0.10)	28.2	> 55	C	Yes	354.7	143
TC3MHR 120-C	0.118	17.6	95.76 x 60.17	120.25 x 63.64	120.34 x 88.14	ø = 128.81	ø = 115.25	334.6	8	<0.08 (0.10)	<0.08 (0.10)	47.4	> 55	C	Yes	440.4	180
TC3MHR 144-C	0.100	17.6	113.00 x 71.00	141.90 x 75.10	142.00 x 104.00	ø = 152.00	ø = 136.00	396.0	8	<0.08 (0.10)	<0.08 (0.10)	66.0	> 55	C	Yes	499.8	200
TC3MHR 192-C	0.075	17.6	150.67 x 94.67	189.20 x 100.13	189.33 x 138.67	ø = 202.67	ø = 181.33	527.6	8	<0.08 (0.10)	<0.08 (0.10)	117.3	> 50	C	Yes	640.3	260
TC3MHR 240-C	0.059	17.6	191.5 x 120.3	240.5 x 127.29	240.68 x 176.27	ø = 257.63	ø = 230.51	492.9	8	<0.08 (0.10)	<0.08 (0.10)	189.6	> 55	C	Yes	801.6	322

TC4MHR series for up to 4/3" sensors

			Detector type					Optical specifications						Mechanical specifications			
			1/1.2" IMX174 / IMX249 13.3 mm diag	1" IMX255 / IMX267 16.1 mm diag	1.1" IMX253 / IMX304 17.6 mm diag	1.2" KAI-4022 / 4021 21.5 mm diag	4/3" KAI-08050 22.6 mm diag										
Part number	Mag. (x)	Image circle Ø (mm)	w x h 11.3 x 7.10 (mm x mm)	w x h 14.19 x 7.51 (mm x mm)	w x h 14.2 x 10.4 (mm x mm)	w x h 15.2 x 15.2 (mm x mm)	w x h 18.1 x 13.6 (mm x mm) 7	WD (mm) 1	wF/# 2	Telecentricity typical (max) (deg) 3	Distortion typical (max) (%) 4	Field depth (mm) 5	CTF @50lp/mm (%)	Mount	Phase adj 9	Length (mm) 6	Diam. (mm)
TC4M lenses			Object field of view (mm x mm) 8														
TC4M 004-C	4.000	22.0	2.83 x 1.78	3.55 x 1.88	3.55 x 2.60	3.80 x 3.80	4.53 x 3.40	57.1	22	<0.08 (0.10)	<0.08 (0.10)	0.1	> 30	C	Yes	206.4	45
TC4M 004-F	4.000	22.0	2.83 x 1.78	3.55 x 1.88	3.55 x 2.60	3.80 x 3.80	4.53 x 3.40	57.1	22	<0.08 (0.10)	<0.08 (0.10)	0.1	> 30	F	Yes	178.4	45
TC4M 007-C	2.667	22.0	4.24 x 2.66	5.32 x 2.82	5.32 x 3.90	5.70 x 5.70	6.79 x 5.10	31.2	22	<0.08 (0.10)	<0.06 (0.10)	0.3	> 30	C	Yes	183.5	45
TC4M 007-F	2.667	22.0	4.24 x 2.66	5.32 x 2.82	5.32 x 3.90	5.70 x 5.70	6.79 x 5.10	31.2	22	<0.08 (0.10)	<0.06 (0.10)	0.3	> 30	F	Yes	155.4	45
TC4M 009-C	2.000	22.0	5.65 x 3.55	7.10 x 3.76	7.10 x 5.20	7.60 x 7.60	9.05 x 6.80	63.3	22	<0.08 (0.10)	<0.05 (0.10)	0.5	> 30	C	Yes	170.0	45
TC4M 009-F	2.000	22.0	5.65 x 3.55	7.10 x 3.76	7.10 x 5.20	7.60 x 7.60	9.05 x 6.80	63.3	22	<0.08 (0.10)	<0.05 (0.10)	0.5	> 30	F	Yes	142.0	45
TC4MHR lenses																	
TC4MHR 016-C	1.055	21.2	10.71 x 6.73	13.45 x 7.12	13.46 x 9.86	14.41 x 14.41	17.16 x 12.89	43.8	16	<0.08 (0.10)	<0.04 (0.10)	1.2	> 30	C	Yes	169.6	45
TC4MHR 016-F	1.055	21.2	10.71 x 6.73	13.45 x 7.12	13.46 x 9.86	14.41 x 14.41	17.16 x 12.89	43.8	16	<0.08 (0.10)	<0.04 (0.10)	1.2	> 30	F	Yes	140.6	64
TC4MHR 016-E	1.055	21.2	10.71 x 6.73	13.45 x 7.12	13.46 x 9.86	14.41 x 14.41	17.16 x 12.89	43.8	16	<0.08 (0.10)	<0.04 (0.10)	1.2	> 30	M42X1 FD16	Yes	171.1	52
TC4MHR 024-C	0.700	21.6	16.14 x 10.14	20.27 x 10.73	20.29 x 14.86	21.71 x 21.71	25.86 x 19.43	57.2	16	<0.08 (0.10)	<0.04 (0.10)	2.7	> 30	C	Yes	194.8	45
TC4MHR 024-F	0.700	21.6	16.14 x 10.14	20.27 x 10.73	20.29 x 14.86	21.71 x 21.71	25.86 x 19.43	57.2	16	<0.08 (0.10)	<0.04 (0.10)	2.7	> 30	F	Yes	165.8	64
TC4MHR 024-E	0.700	21.6	16.14 x 10.14	20.27 x 10.73	20.29 x 14.86	21.71 x 21.71	25.86 x 19.43	57.2	16	<0.08 (0.10)	<0.04 (0.10)	2.7	> 30	M42X1 FD16	Yes	196.3	52
TC4MHR 036-C	0.486	21.4	23.25 x 14.61	29.20 x 15.45	29.22 x 21.40	31.28 x 31.28	37.24 x 27.98	102.6	16	<0.05 (0.10)	<0.08 (0.10)	5.6	> 30	C	Yes	222.0	61
TC4MHR 036-F	0.486	21.4	23.25 x 14.61	29.20 x 15.45	29.22 x 21.40	31.28 x 31.28	37.24 x 27.98	102.6	16	<0.05 (0.10)	<0.08 (0.10)	5.6	> 30	F	Yes	193.0	64
TC4MHR 036-E	0.486	21.4	23.25 x 14.61	29.20 x 15.45	29.22 x 21.40	31.28 x 31.28	37.24 x 27.98	102.6	16	<0.05 (0.10)	<0.08 (0.10)	5.6	> 30	M42X1 FD16	Yes	223.6	61
TC4MHR 048-C	0.369	21.7	30.62 x 19.24	38.46 x 20.35	38.48 x 28.18	41.19 x 41.19	49.05 x 36.86	133.4	16	<0.08 (0.10)	<0.08 (0.10)	9.7	> 40	C	Yes	257.1	75
TC4MHR 048-F	0.369	21.7	30.62 x 19.24	38.46 x 20.35	38.48 x 28.18	41.19 x 41.19	49.05 x 36.86	133.4	16	<0.08 (0.10)	<0.08 (0.10)	9.7	> 40	F	Yes	228.1	75
TC4MHR 048-E	0.369	21.7	30.62 x 19.24	38.46 x 20.35	38.48 x 28.18	41.19 x 41.19	49.05 x 36.86	133.4	16	<0.08 (0.10)	<0.08 (0.10)	9.7	> 40	M42X1 FD16	Yes	258.6	75
TC4MHR 056-C	0.314	21.6	35.99 x 22.61	45.19 x 23.92	45.22 x 33.12	48.41 x 48.41	57.64 x 43.31	157.8	16	<0.05 (0.10)	<0.04 (0.10)	13.4	> 40	C	Yes	280.7	80
TC4MHR 056-F	0.314	21.6	35.99 x 22.61	45.19 x 23.92	45.22 x 33.12	48.41 x 48.41	57.64 x 43.31	157.8	16	<0.05 (0.10)	<0.04 (0.10)	13.4	> 40	F	Yes	251.7	80
TC4MHR 056-E	0.314	21.6	35.99 x 22.61	45.19 x 23.92	45.22 x 33.12	48.41 x 48.41	57.64 x 43.31	157.8	16	<0.05 (0.10)	<0.04 (0.10)	13.4	> 40	M42X1 FD16	Yes	282.2	80
TC4MHR 064-C	0.275	21.6	41.09 x 25.82	51.60 x 27.31	51.64 x 37.82	55.27 x 55.27	65.82 x 49.45	181.9	16	<0.05 (0.10)	<0.04 (0.10)	17.5	> 40	C	Yes	301.8	100
TC4MHR 064-F	0.275	21.6	41.09 x 25.82	51.60 x 27.31	51.64 x 37.82	55.27 x 55.27	65.82 x 49.45	181.9	16	<0.05 (0.10)	<0.04 (0.10)	17.5	> 40	F	Yes	272.8	100
TC4MHR 064-E	0.275	21.6	41.09 x 25.82	51.60 x 27.31	51.64 x 37.82	55.27 x 55.27	65.82 x 49.45	181.9	16	<0.05 (0.10)	<0.04 (0.10)	17.5	> 40	M42X1 FD16	Yes	303.4	100
TC4MHR 080-C	0.221	21.7	51.13 x 32.13	64.21 x 33.98	64.25 x 47.06	68.78 x 68.78	81.90 x 61.54	226.8	16	<0.05 (0.10)	<0.04 (0.10)	27.0	> 40	C	Yes	347.6	116
TC4MHR 080-F	0.221	21.7	51.13 x 32.13	64.21 x 33.98	64.25 x 47.06	68.78 x 68.78	81.90 x 61.54	226.8	16	<0.05 (0.10)	<0.04 (0.10)	27.0	> 40	F	Yes	318.6	116
TC4MHR 080-E	0.221	21.7	51.13 x 32.13	64.21 x 33.98	64.25 x 47.06	68.78 x 68.78	81.90 x 61.54	226.8	16	<0.05 (0.10)	<0.04 (0.10)	27.0	> 40	M42X1 FD16	Yes	349.1	116
TC4MHR 096-C	0.186	21.6	60.75 x 38.17	76.29 x 40.38	76.34 x 55.91	81.72 x 81.72	97.31 x 73.12	278.6	16	<0.05 (0.10)	<0.04 (0.10)	38.2	> 35	C	Yes	392.8	143
TC4MHR 096-F	0.186	21.6	60.75 x 38.17	76.29 x 40.38	76.34 x 55.91	81.72 x 81.72	97.31 x 73.12	278.6	16	<0.05 (0.10)	<0.04 (0.10)	38.2	> 35	F	Yes	363.8	143
TC4MHR 096-E	0.186	21.6	60.75 x 38.17	76.29 x 40.38	76.34 x 55.91	81.72 x 81.72	97.31 x 73.12	278.6	16	<0.05 (0.10)	<0.04 (0.10)	38.2	> 35	M42X1 FD16	Yes	394.3	143
TC4MHR 120-C	0.143	21.2	79.02 x 49.65	99.23 x 52.52	99.30 x 72.73	106.29 x 106.29	126.57 x 95.10	334.6	16	<0.05 (0.10)	<0.04 (0.10)	64.6	> 30	C	Yes	475.2	180
TC4MHR 120-F	0.143	21.2	79.02 x 49.65	99.23 x 52.52	99.30 x 72.73	106.29 x 106.29	126.57 x 95.10	334.6	16	<0.05 (0.10)	<0.04 (0.10)	64.6	> 30	F	Yes	446.2	180
TC4MHR 120-E	0.143	21.2	79.02 x 49.65	99.23 x 52.52	99.30 x 72.73	106.29 x 106.29	126.57 x 95.10	334.6	16	<0.05 (0.10)	<0.04 (0.10)	64.6	> 30	M42X1 FD16	Yes	476.7	180
TC4MHR 144-C	0.122	21.6	92.62 x 58.20	116.31 x 61.56	116.39 x 85.25	124.59 x 124.59	148.36 x 111.48	396.0	16	<0.05 (0.10)	<0.04 (0.10)	88.7	> 30	C	Yes	537.7	200
TC4MHR 144-F	0.122	21.6	92.62 x 58.20	116.31 x 61.56	116.39 x 85.25	124.59 x 124.59	148.36 x 111.48	396.0	16	<0.05 (0.10)	<0.04 (0.10)	88.7	> 30	F	Yes	508.7	200
TC4MHR 144-E	0.122	21.6	92.62 x 58.20	116.31 x 61.56	116.39 x 85.25	124.59 x 124.59	148.36 x 111.48	396.0	16	<0.05 (0.10)	<0.04 (0.10)	88.7	> 30	M42X1 FD16	Yes	539.2	200
TC4MHR 192-C	0.092	21.6	122.83 x 77.17	154.24 x 81.63	154.35 x 113.04	165.22 x 165.22	196.74 x 147.83	527.6	16	<0.05 (0.10)	<0.04 (0.10)	156.0	> 30	C	Yes	679.1	260
TC4MHR 192-F	0.092	21.6	122.83 x 77.17	154.24 x 81.63	154.35 x 113.04	165.22 x 165.22	196.74 x 147.83	527.6	16	<0.05 (0.10)	<0.04 (0.10)	156.0	> 30	F	Yes	650.1	260
TC4MHR 192-E	0.092	21.6	122.83 x 77.17	154.24 x 81.63	154.35 x 113.04	165.22 x 165.22	196.74 x 147.83	527.6	16	<0.05 (0.10)	<0.04 (0.10)	156.0	> 30	M42X1 FD16	Yes	680.7	260
TC4MHR 240-C	0.073	21.1	154.79 x 97.26	194.38 x 102.88	194.52 x 142.47	208.22 x 208.22	247.95 x 186.30	492.9	16	<0.05 (0.10)	<0.05 (0.10)	247.7	> 30	C	Yes	827.3	322
TC4MHR 240-F	0.073	21.1	154.79 x 97.26	194.38 x 102.88	194.52 x 142.47	208.22 x 208.22	247.95 x 186.30	492.9	16	<0.05 (0.10)	<0.05 (0.10)	247.7	> 30	F	Yes	798.3	322
TC4MHR 240-E	0.073	21.1	154.79 x 97.26	194.38 x 102.88	194.52 x 142.47	208.22 x 208.22	247.95 x 186.30	492.9	16	<0.05 (0.10)	<0.05 (0.10)	247.7	> 30	M42X1 FD16	Yes	828.8	322

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 (higher wF#) 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..
7 With KAI-08050 (22.6 mm diagonal) detectors, the FOV of TC4MHRyyy-x lenses may show some vignetting at the image corners
8 For the fields with the indication "Ø =", the image of a circular object of such diameter is fully inscribed into the detector.
9 Indicates the availability of an integrated camera phase adjustment feature.

Ordering information

It's easy to select the right lens for your application: our part numbers are coded as **TC1MHR yyy-x**, **TC2MHR yyy-x**, **TC3MHR 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.

TC1MHR-TC4MHR CORE series

Ultra compact high-resolution telecentric lenses up to 4/3"

NEW MODELS

Vision Systems Design 2016 Innovators Awards GOLD

inVISION TOP INNOVATION 2016

INTERNATIONAL PATENT PENDING

KEY ADVANTAGES

Excellent optical performance
TC1MHR-TC4MHR CORE telecentric lenses deliver excellent optical performance as other comparable Opto Engineering® telecentric lenses.

Extremely compact
TC1MHR-TC4MHR CORE lenses are up to 70% smaller than other telecentric lenses on the market.

Designed for flexibility and smart integration
TC1MHR-TC4MHR CORE lenses integrate a camera phase adjustment and can be mounted on multiple sides with or without clamps, allowing you to cut costs.

Save you money
Systems integrating TC1MHR-TC4MHR CORE lenses take much less space, resulting in lower manufacturing, shipping and storage costs.

Boost your sales
A smaller vision system or measurement machine is the solution preferred by the industry.

Detailed test report with measured optical parameters.

TC1MHR-TC4MHR CORE series are ultra compact telecentric lenses tailored for high-resolution sensors up to 4/3".

TC1MHR-TC4MHR CORE lenses deliver excellent optical performance in a super compact shape. Thanks to the unique opto-mechanical design, these lenses offer very high resolution, nearly zero distortion and high field depth while saving up to 70% in length compared to similar FOV lenses on the market.

TC1MHR-TC4MHR CORE lenses ensure hassle-free integration in a measurement system. The rear phase adjustment allows the user to easily align the camera sensor to the sample.

These lenses can be mounted in several orientations thanks to the M6 threads located on multiple sides, even without clamps.
For maximum flexibility, a special front mounting clamp is also available.

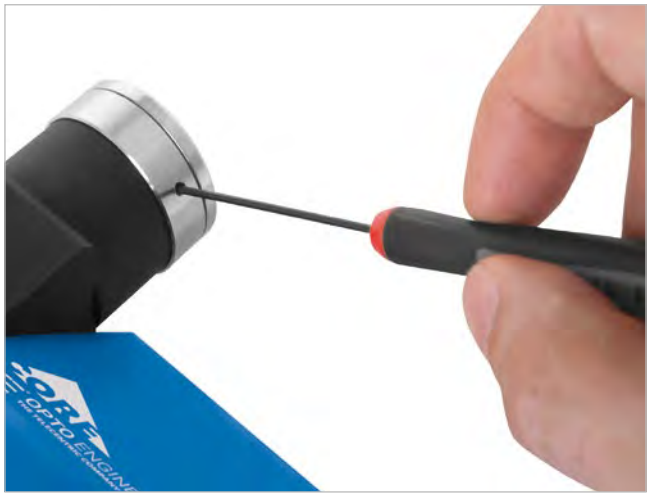
Comparison of a "classic" telecentric lens and a TC CORE telecentric lens:
TC CORE lens delivers best optical performance and is extremely compact.

FULL RANGE OF COMPATIBLE ILLUMINATORS		
	LTCLHP CORE series	p. 134
FULL RANGE OF COMPATIBLE PRODUCTS		
	CMHOCR series	p. 231
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205
	COE HR AS-X series	p. 207

TCCR2M080-C
with C Mount

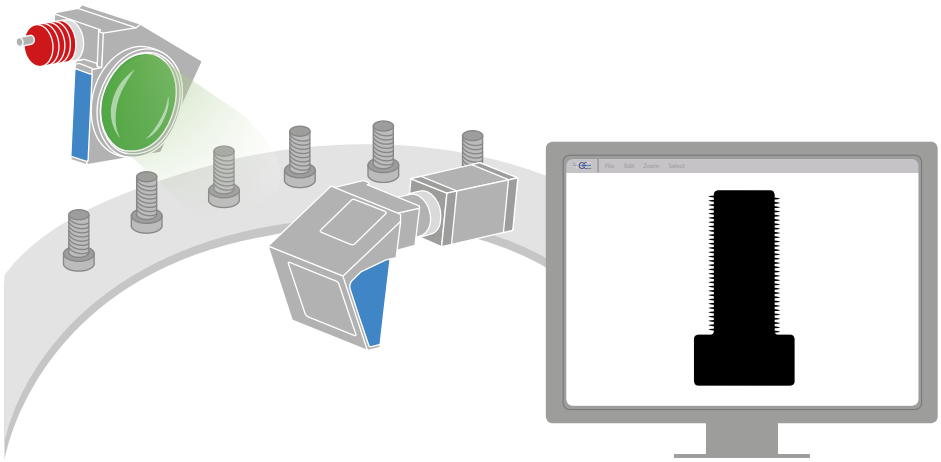
TCCR4M096-E
with E Mount (M42x1)

TCCR4M056-F
with F Mount



Built-in phase adjustment makes it easy to align the camera sensor.

Application example

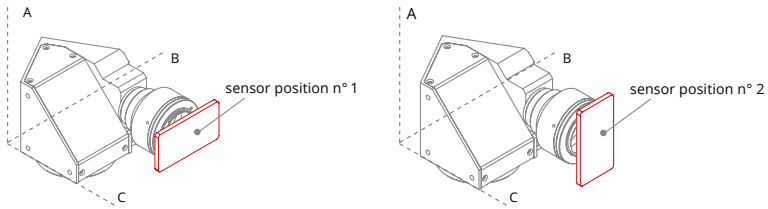


Standard solution
with a 4/3” camera,
TC4MHR CORE lens
and a LTCLHP CORE illuminator.

TC1MHR-TC4MHR CORE series

Ultra compact high-resolution telecentric lenses up to 4/3"

TC1MHR-TC4MHR CORE lens dimensions (A, B, C) and correct position of the sensor in relation to the lens:



The long side of sensor has to be aligned along axis B (position n°1) or axis A (pisition n°2).

Technical information:

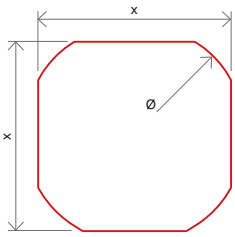


Image shape dimensions (Ø, x).

TC1MHR CORE series for up to 1/1.2" sensors

			Detector type					Optical specifications							Mechanical specifications				
Part number	Mag. (x)	Image shape dimensions Ø,x (mm) 8	1/1.2" IMX174 / IMX249 13.3 mm diag. w x h 11.3 x 7.1 (mm x mm)	1" KAI-04050 16 mm diag. w x h 12.8 x 9.6 (mm x mm)	1.1" IMX253 / IMX304 17.6 mm diag. w x h 14.2 x 10.4 (mm x mm)	1.2" KAI-4022 / 4021 21.5 mm diag. w x h 15.2 x 15.2 (mm x mm)	4/3" KAI-08050 22.6 mm diag. w x h 18.1 x 13.6 (mm x mm)	WD (mm) 1	wF/# 2	Telecentricity typical (max) (deg) 3	Distortion typical (max) (%) 4	Field depth (mm) 5	CTF @50lp/mm (%)	Mount	Phase adj. 7	Dimensions (mm) A	B	C
			Object field of view (mm x mm) 6																
TCCR1M 048-C	0.222	Ø=13.3, x=11.6	50.9 x 32.0	Ø=60, x=43	Ø=60, x=47	Ø=60, x=52	Ø=60, x=52	132.4	8	< 0.08 (0.10)	< 0.08 (0.10)	13.4	> 55	C	Yes	77	106	144
TCCR1M 056-C	0.190	Ø=13.4, x=11.6	59.5 x 37.4	Ø=71, x=51	Ø=71, x=55	Ø=71, x=61	Ø=71, x=61	157.8	8	< 0.08 (0.10)	< 0.08 (0.10)	18.3	> 55	C	Yes	94	110	154
TCCR1M 064-C	0.166	Ø=13.7, x=11.5	68.1 x 42.8	Ø=83, x=58	Ø=83, x=63	Ø=83, x=69	Ø=83, x=69	181.9	8	< 0.08 (0.10)	< 0.08 (0.10)	24.0	> 55	C	Yes	101	122	162
TCCR1M 080-C	0.134	Ø=13.4, x=11.5	84.3 x 53.0	Ø=100, x=72	Ø=100, x=78	Ø=100, x=86	Ø=100, x=86	226.8	8	< 0.08 (0.10)	< 0.08 (0.10)	36.8	> 50	C	Yes	119	145	181
TCCR1M 096-C	0.114	Ø=13.7, x=11.3	99.1 x 62.3	Ø=120, x=84	Ø=120, x=91	Ø=120, x=99	Ø=120, x=99	278.6	8	< 0.08 (0.10)	< 0.08 (0.10)	50.8	> 55	C	Yes	139	172	198
TCCR1M 120-C	0.087	Ø=13.5, x=11.1	129.9 x 81.6	Ø=155, x=110	Ø=155, x=120	Ø=155, x=128	Ø=155, x=128	334.6	8	< 0.08 (0.10)	< 0.08 (0.10)	87.2	> 55	C	Yes	182	220	231

TC2MHR CORE series for up to 1" sensors

			Detector type					Optical specifications							Mechanical specifications				
Part number	Mag. (x)	Image shape dimensions Ø,x (mm) 8	1/1.2" IMX174 / IMX249 13.3 mm diag. w x h 11.3 x 7.1 (mm x mm)	1" KAI-04050 16 mm diag. w x h 12.8 x 9.6 (mm x mm)	1.1" IMX253 / IMX304 17.6 mm diag. w x h 14.2 x 10.4 (mm x mm)	1.2" KAI-4022 / 4021 21.5 mm diag. w x h 15.2 x 15.2 (mm x mm)	4/3" KAI-08050 22.6 mm diag. w x h 18.1 x 13.6 (mm x mm)	WD (mm) 1	wF/# 2	Telecentricity typical (max) (deg) 3	Distortion typical (max) (%) 4	Field depth (mm) 5	CTF @50lp/mm (%)	Mount 9	Phase adj. 7	Dimensions (mm) A	B	C
			Object field of view (mm x mm) 6																
TCCR2M 048-C	0.268	Ø=16.1, x=13.9	42.2 x 26.5	47.8 x 35.8	Ø=60, x=39	Ø=60, x=52	Ø=60, x=51	133.4	16	< 0.08 (0.10)	< 0.08 (0.10)	18	> 30	C	Yes	77	109	168
TCCR2M 048-E	0.268	Ø=16.1, x=13.9	42.2 x 26.5	47.8 x 35.8	Ø=60, x=39	Ø=60, x=52	Ø=60, x=51	133.4	16	< 0.08 (0.10)	< 0.08 (0.10)	18	> 30	M42x1 FD 16	Yes	77	112	170
TCCR2M 056-C	0.228	Ø=16.2, x=13.9	49.6 x 31.1	56.1 x 42.1	Ø=71, x=46	Ø=71, x=61	Ø=71, x=60	157.8	16	< 0.04 (0.08)	< 0.05(0.10)	25	> 40	C	Yes	94	112	178
TCCR2M 056-E	0.228	Ø=16.2, x=13.9	49.6 x 31.1	56.1 x 42.1	Ø=71, x=46	Ø=71, x=61	Ø=71, x=60	157.8	16	< 0.04 (0.08)	< 0.05(0.10)	25	> 40	M42x1 FD 16	Yes	94	114	178
TCCR2M 064-C	0.200	Ø=16.6, x=14.0	56.5 x 35.5	64.0 x 48.0	Ø=83, x=52	Ø=83, x=70	Ø=83, x=68	181.9	16	< 0.04 (0.08)	< 0.05 (0.10)	33	> 40	C	Yes	101	125	185
TCCR2M 064-E	0.200	Ø=16.6, x=14.0	56.5 x 35.5	64.0 x 48.0	Ø=83, x=52	Ø=83, x=70	Ø=83, x=68	181.9	16	< 0.04 (0.08)	< 0.05 (0.10)	33	> 40	M42x1 FD 16	Yes	101	127	187
TCCR2M 080-C	0.160	Ø=16.3, x=13.8	70.6 x 44.4	80.0 x 60.0	Ø=102, x=65	Ø=102, x=86	Ø=102, x=85	227	16	< 0.04 (0.08)	< 0.05 (0.10)	52	> 40	C	Yes	119	145	205
TCCR2M 080-E	0.160	Ø=16.3, x=13.8	76 x 44.4	80.0 x 60.0	Ø=102, x=65	Ø=102, x=86	Ø=102, x=85	227	16	< 0.04 (0.08)	< 0.05 (0.10)	52	> 40	M42x1 FD 16	Yes	119	149	207
TCCR2M 096-C	0.137	Ø=16.7, x=13.7	82.5 x 51.8	93.4 x 70.1	Ø=122, x=76	Ø=122, x=100	Ø=122, x=99	278.6	16	< 0.05 (0.10)	< 0.07 (0.10)	70	> 40	C	Yes	139	172	230
TCCR2M 096-E	0.137	Ø=16.7, x=13.7	82.5 x 51.8	93.4 x 70.1	Ø=122, x=76	Ø=122, x=100	Ø=122, x=99	279	16	< 0.05 (0.10)	< 0.07 (0.10)	70	> 40	M42x1 FD 16	Yes	139	172	232
TCCR2M 120-C	0.104	Ø=16.4, x=13.4	108.7 x 68.3	123.1 x 92.3	Ø=158, x=100	Ø=158, x=129	Ø=158, x=129	335	16	< 0.06 (0.10)	< 0.08 (0.10)	122	> 40	C	Yes	182	220	258
TCCR2M 120-E	0.104	Ø=16.4, x=13.4	108.7 x 68.3	123.1 x 92.3	Ø=158, x=100	Ø=158, x=129	Ø=158, x=129	335	16	< 0.06 (0.10)	< 0.08 (0.10)	122	> 40	M42x1 FD 16	Yes	182	220	260
TCCR2M 120-F	0.104	Ø=16.4, x=13.4	108.7 x 68.3	123.1 x 92.3	Ø=158, x=100	Ø=158, x=129	Ø=158, x=129	335	16	< 0.06 (0.10)	< 0.08 (0.10)	122	> 40	F	Yes	182	220	233

TC3MHR CORE series for up to 1.1" sensors

			Detector type					Optical specifications							Mechanical specifications				
Part number	Mag.	Image shape dimensions Ø,x (mm) 8	1/1.2" IMX174 / IMX249 13.3 mm diag. w x h 11.3 x 7.1 (mm x mm)	1" KAI-04050 16 mm diag. w x h 12.8 x 9.6 (mm x mm)	1.1" IMX253 / IMX304 17.6 mm diag. w x h 14.2 x 10.4 (mm x mm)	1.2" KAI-4022 / 4021 21.5 mm diag. w x h 15.2 x 15.2 (mm x mm)	4/3" KAI-08050 22.6 mm diag. w x h 18.1 x 13.6 (mm x mm)	WD (mm) 1	wF/# 2	Telecentricity typical (max) (deg) 3	Distortion typical (max) (%) 4	Field depth (mm) 5	CTF @50lp/mm (%)	Mount	Phase adj. 7	Dimensions (mm) A	B	C
	(x)		Object field of view (mm x mm) 6																
TCCR3M 048-C	0.303	Ø=17.6, x=15.2	37.3 x 23.4	42.2 x 31.7	46.9 x 34.3	Ø=58, x=50	Ø=58, x=45	132.9	8	< 0.08 (0.10)	< 0.08 (0.10)	7.2	> 50	C	Yes	77	106	153
TCCR3M 056-C	0.259	Ø=17.6, x=15.2	43.6 x 27.4	49.4 x 37.1	54.8 x 40.2	Ø=68, x=59	Ø=68, x=53	157.8	8	< 0.08 (0.10)	< 0.08 (0.10)	9.8	> 55	C	Yes	94	110	162
TCCR3M 064-C	0.227	Ø=17.9, x=15.1	49.8 x 31.3	56.4 x 42.3	62.6 x 45.8	Ø=79, x=67	Ø=79, x=60	181.9	8	< 0.08 (0.10)	< 0.08 (0.10)	12.8	> 55	C	Yes	101	122	171
TCCR3M 080-C	0.182	Ø=17.7, x=15.0	62.1 x 39.0	70.3 x 52.7	78.0 x 57.1	Ø=97, x=82	Ø=97, x=86	226.8	8	< 0.08 (0.10)	< 0.08 (0.10)	19.9	> 50	C	Yes	119	145	190
TCCR3M 096-C	0.153	Ø=17.9, x=14.8	73.9 x 46.4	83.7 x 62.7	92.8 x 68.0	Ø=117, x=97	Ø=117, x=89	278.6	8	< 0.08 (0.10)	< 0.08 (0.10)	28.2	> 55	C	Yes	139	172	210
TCCR3M 120-C	0.118	Ø=17.8, x=14.6	95.8 x 60.2	108.5 x 81.4	120.3 x 88.1	Ø=151, x=124	Ø=151, x=115	334.6	8	< 0.08 (0.10)	< 0.08 (0.10)	47.4	> 55	C	Yes	182	220	243

TC4MHR CORE series for up to 4.3" sensors

			Detector type					Optical specifications							Mechanical specifications				
Part number	Mag.	Image shape dimensions Ø,x (mm) 8	1/1.2" IMX174 / IMX249 13.3 mm diag. w x h 11.3 x 7.1 (mm x mm)	1" KAI-04050 16 mm diag. w x h 12.8 x 9.6 (mm x mm)	1.1" IMX253 / IMX304 17.6 mm diag. w x h 14.2 x 10.4 (mm x mm)	1.2" KAI-4022 / 4021 21.5 mm diag. w x h 15.2 x 15.2 (mm x mm)	4/3" KAI-08050 22.6 mm diag. w x h 18.1 x 13.6 (mm x mm)	WD (mm) 1	wF/# 2	Telecentricity typical (max) (deg) 3	Distortion typical (max) (%) 4	Field depth (mm) 5	CTF @50lp/mm (%)	Mount 9	Phase adj. 7	Dimensions (mm) A	B	C
	(x)		Object field of view (mm x mm) 6																
TCCR4M 048-C	0.369	Ø=22.1, x=18.8	30.6 x 19.2	34.7 x 26.0	38.5 x 28.2	41.2 x 41.2	49.1 x 36.9	133.4	16	< 0.08 (0.10)	< 0.08 (0.10)	10	> 40	C	Yes	77	109	193
TCCR4M 048-F	0.369	Ø=22.1, x=18.8	30.6 x 19.2	34.7 x 26.0	38.5 x 28.2	41.2 x 41.2	49.1 x 36.9	133.4	16	< 0.08 (0.10)	< 0.08 (0.10)	10	> 40	F	Yes	77	118	163
TCCR4M 048-E	0.369	Ø=22.1, x=18.8	30.6 x 19.2	34.7 x 26.0	38.5 x 28.2	41.2 x 41.2	49.1 x 36.9	133.4	16	< 0.08 (0.10)	< 0.08 (0.10)	10	> 40	M42x1 FD 16	Yes	77	112	195
TCCR4M 056-C	0.314	Ø=22.0, x=19.2	36.0 x 22.6	40.8 x 30.6	45.2 x 33.1	48.4 x 48.4	57.6 x 43.3	157.8	16	< 0.05 (0.10)	< 0.04 (0.10)	13	> 40	C	Yes	94	112	202
TCCR4M0 56-F	0.314	Ø=22.0, x=19.2	36.0 x 22.6	40.8 x 30.6	45.2 x 33.1	48.4 x 48.4	57.6 x 43.3	157.8	16	< 0.05 (0.10)	< 0.04 (0.10)	13	> 40	F	Yes	94	119	173
TCCR4M 056-E	0.314	Ø=22.0, x=19.2	36.0 x 22.6	40.8 x 30.6	45.2 x 33.1	48.4 x 48.4	57.6 x 43.3	157.8	16	< 0.05 (0.10)	< 0.04 (0.10)	13	> 40	M42x1 FD 16	Yes	94	115	204
TCCR4M 064-C	0.275	Ø=22.6, x=18.7	41.1 x 25.8	46.5 x 34.9	51.6 x 37.8	55.3 x 55.3	65.8 x 49.5	181.9	16	< 0.05 (0.10)	< 0.04 (0.10)	17	> 40	C	Yes	101	124	208
TCCR4M 064-F	0.275	Ø=22.6, x=18.7	41.1 x 25.8	46.5 x 34.9	51.6 x 37.8	55.3 x 55.3	65.8 x 49.5	181.9	16	< 0.05 (0.10)	< 0.04 (0.10)	17	> 40	F	Yes	101	129	180
TCCR4M 064-E	0.275	Ø=22.6, x=18.7	41.1 x 25.8	46.5 x 34.9	51.6 x 37.8	55.3 x 55.3	65.8 x 49.5	181.9	16	< 0.05 (0.10)	< 0.04 (0.10)	17	> 40	M42x1 FD 16	Yes	101	127	211
TCCR4M 080-C	0.221	Ø=22.3, x=19.0	51.1 x 32.1	57.9 x 43.4	64.3 x 47.1	68.8 x 68.8	81.9 x 61.5	226.8	16	< 0.05 (0.10)	< 0.04 (0.10)	27	> 40	C	Yes	119	146	228
TCCR4M 080-F	0.221	Ø=22.3, x=19.0	51.1 x 32.1	57.9 x 43.4	64.3 x 47.1	68.8 x 68.8	81.9 x 61.5	226.8	16	< 0.05 (0.10)	< 0.04 (0.10)	27	> 40	F	Yes	119	152	199
TCCR4M 080-E	0.221	Ø=22.3, x=19.0	51.1 x 32.1	57.9 x 43.4	64.3 x 47.1	68.8 x 68.8	81.9 x 61.5	226.8	16	< 0.05 (0.10)	< 0.04 (0.10)	27	> 40	M42x1 FD 16	Yes	119	148	231
TCCR4M 096-C	0.186	Ø=22.5, x=18.6	60.8 x 38.2	68.8 x 51.6	76.3 x 55.9	81.7 x 81.7	97.3 x 73.1	278.6	16	< 0.05 (0.10)	< 0.04 (0.10)	38	> 35	C	Yes	139	172	254
TCCR4M 096-F	0.186	Ø=22.5, x=18.6	60.8 x 38.2	68.8 x 51.6	76.3 x 55.9	81.7 x 81.7	97.3 x 73.1	278.6	16	< 0.05 (0.10)	< 0.04 (0.10)	38	> 35	F	Yes	139	175	225
TCCR4M 096-E	0.186	Ø=22.5, x=18.6	60.8 x 38.2	68.8 x 51.6	76.3 x 55.9	81.7 x 81.7	97.3 x 73.1	278.6	16	< 0.05 (0.10)	< 0.04 (0.10)	38	> 35	M42x1 FD 16	Yes	139	173	256
TCCR4M 120-C	0.143	Ø=22.3, x=18.2	79.0 x 49.7	89.5 x 67.1	99.3 x 72.7	106.3 x 106.3	126.6 x 95.1	334.6	16	< 0.06 (0.10)	< 0.08 (0.10)	65	> 30	C	Yes	182	220	278
TCCR4M 120-F	0.143	Ø=22.3, x=18.2	79.0 x 49.7	89.5 x 67.1	99.3 x 72.7	106.3 x 106.3	126.6 x 95.1	334.6	16	< 0.06 (0.10)	< 0.08 (0.10)	65	> 30	F	Yes	182	220	249
TCCR4M 120-E	0.143	Ø=22.3, x=18.2	79.0 x 49.7	89.5 x 67.1	99.3 x 72.7	106.3 x 106.3	126.6 x 95.1	334.6	16	< 0.06 (0.10)	< 0.08 (0.10)	65	> 30	M42x1 FD 16	Yes	182	220	280

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 (higher wF#) 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 In case the of vignetting, FOV dimensions are indicated with "Ø = , x= ", where "Ø =" stands for diameter and "x=" indicates the nominal FOV height and length (see TechInfo for related drawing).
7 Indicates the availability of an integrated camera phase adjustment feature.
8 Indicates the dimensions and shape of image, where "Ø =" stands for diameter and "x=" indicates the nominal image height and length (see Tech Info for related drawing).
9 M42x1 mpunt has a flange distance of 16 mm.

TC3MHR-TC5MHR CORE PLUS series

Ultra compact large FOV telecentric lenses for matrix detectors up to 4/3"

NEW

INTERNATIONAL PATENT PENDING

KEY ADVANTAGES

Make your large FOV system up to 45% smaller
TC3MHR-5MHR CORE PLUS lenses are up to 45% shorter than other telecentric lenses on the market. The short working distance minimizes the size of the whole system.

Designed for the latest camera sensors
TC3MHR CORE PLUS telecentric lenses are designed for sensors up to 1.1" like the IMX304, while TC5MHR CORE PLUS series lenses are ideal for sensors up to 4/3" like the KAC-12040.

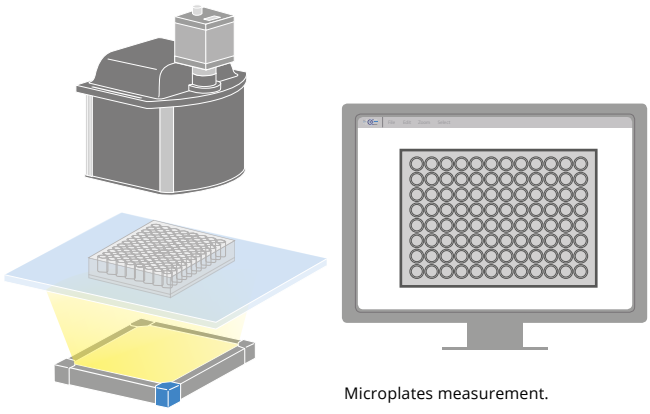
Smart integration
TC3MHR-5MHR CORE PLUS lenses integrate a mouting flange for easy integration without additional clamps.

System compactness is a competitive advantage
TC CORE PLUS lenses minimize the size of your system, resulting in less manufacturing, shipping and storage costs.

TC3MHR-5MHR CORE PLUS series are large FOV telecentric lenses for the latest generation sensors up to 1.1" like the IMX304 and 4/3" sensors like the KAC-12040. They are specifically designed to accurately measure large objects in a reduced space.
Inspired by catadioptric telescopes, their folded optical path allows large FOV imaging while keeping the overall footprint compact. The size reduction is up to 45% compared with other telecentric lenses on the market.

The length and working distance of a telecentric lens strongly impact the size of a vision system. This is especially critical when a large FOV telecentric lens is used with a telecentric illuminator, as the overall dimensions of the system are doubled. For this reason the working distance of TC3MHR-5MHR CORE PLUS series has been reduced to make a measurement system as compact as possible.

Application example:



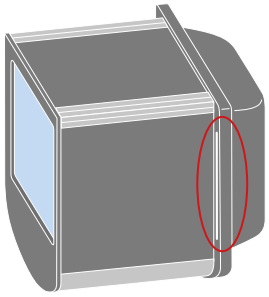
Microplates measurement.

ADVANTAGES

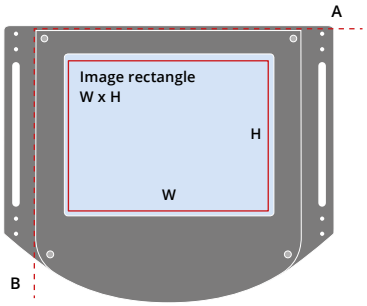
Save more
- Lower manufacturing cost due to less material employed
- Cost of mounting is reduced as no addictional clamps are needed
- Less space required for storage and use
- Lower shipment expenses due to smaller size
- Lower transportation risks

Sell more
- A smaller system leads to more sales

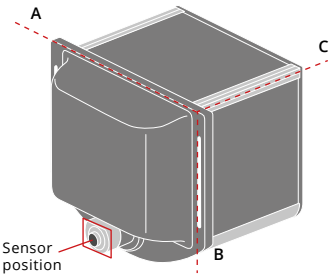
Compatible backlights		LT2BC series		LTBC series		LTBP series	
	FOV max. (mm)	Part Number	Lighting area dim. (mm)	Part Number	Lighting area dim. (mm)	Part Number	Lighting area dim. (mm)
TCCP3 MHR 144	165.4 x 121.0	LT2BC192144-X	192 x 144	LTBC174174-X	174.5 x 174.5	LTBP192144-X	192 x 144
TCCP3 MHR 192	221.4 x 161.9	LT2BC240180-X	192 x 144	LTBC174174-X	174.5 x 174.5	LTBP192144-X	192 x 144
TCCP5 MHR 144	161.2 x 121.1	LT2BC192144-X	240 x 180	LTBC234234-X	234.5 x 234.5	LTBP240180-X	240 x 180
TCCP5 MHR 192	215.7 x 162.0	LT2BC240180-X	240 x 180	LTBC234234-X	234.5 x 234.5	LTBP240180-X	240 x 180



Built-in mounting flange: no additional clamps required.

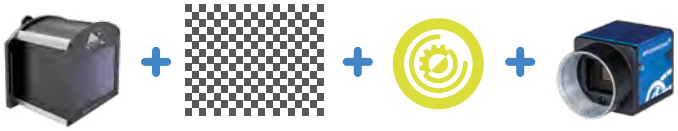


The width of the FOV (W) is aligned along the A axis.
The heigth of the FOV (H) is aligned along the B axis.



The long side of the sensor has to be aligned along the A axis.

Recommended product setup:



TC CORE PLUS telecentric lens

PTCPxxxxx calibration chess-board pattern

TCLIB Suite software library

Fully GenICam® compliant camera

FULL RANGE OF COMPATIBLE TELECENTRIC ILLUMINATORS		
	LTCLHP CORE PLUS series	p. 134
FULL RANGE OF COMPATIBLE BACKLIGHTS		
	LT2BC, LTBC, LTBP series	p. 162-168
FULL RANGE OF COMPATIBLE ACCESSORIES		
	PTCP calibration patterns	p. 250
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205
	COE HR AS-X series	p. 207

For best measurement accuracy, TC CORE PLUS telecentric lenses should be used with:

- TCLIB Suite, an Opto Engineering® proprietary software library for distortion calibration and overall optimization of telecentric measurement setups (see pag. 220)
- a fully GenICam® compliant camera (see pag. 196-205)
- a specifically designed PTCPxxxxx chessboard calibration pattern (see pag. 250)

			Detector type					Optical specifications								Mechanical specifications				
Part number	Mag.	Image rectangle	1/1.2" IMX174 / IMX249 13.3 mm diag. w x h	1" IMX255 / IMX267 16.1 mm diag. w x h	1.1" IMX253 / IMX304 17.6 mm diag. w x h	1.2" KAI-4022/ 4021 21.5 mm diag. w x h	4/3" KAI-0805 23.6 mm diag. w x h	WD	wF/#	Tele-centricity	Distor-tion	Residual distortion	Field depth	CTF		Mount	Phase adj.	Dimensions		
			11.3 x 7.1	14.19 x 7.51	14.2 x 10.4	15.2 x 15.2	18.1 x 13.6			(max)	(max)			@50lp/mm						
	(x)	(mm × mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm x mm)	(mm)		(deg)	(%)		(mm)	(%)				(mm)		
		1	Object field of view (mm x mm)					2	3	4	5	6	7				8	A 9	B	C 10
TCCP3 MHR 144-C	0.086	14.90 x 10.90	131.7 x 82.8	165.4 x 87.5	165.5 x 121.2	-	-	232.0	11	<0.08 (0.10)	< 0.6	< 0.01	77	> 40		C	Yes	332.0	302.5	339.4
TCCP3 MHR 192-C	0.064	14.90 x 10.90	176.3 x 110.8	221.4 x 117.2	221.5 x 162.2	-	-	288.0	10	<0.08 (0.10)	< 0.6	< 0.01	126	> 45		C	Yes	410.4	344.1	365.0
TCCP5 MHR 144-F	0.117	19.82 x 14.88	96.5 x 60.7	121.2 x 64.2	121.3 x 88.8	129.8 x 129.8	154.6 x 116.2	216.9	14	<0.08 (0.10)	< 0.6	< 0.01	53	> 35		F	Yes	332.0	302.5	350.4
TCCP5 MHR 192-F	0.088	19.82 x 14.88	129.1 x 81.1	162.2 x 85.8	162.3 x 118.9	173.7 x 173.7	206.9 x 155.4	288.0	12	<0.08 (0.10)	< 0.6	< 0.01	81	> 40		F	Yes	410.4	344.1	370.8

Residual distortion after calibration with TCLIB Suite software library, using PTCPXXX calibration pattern and fully GenICam® compliant camera.
For specific setup information see the table below:

Part number	Calibrations software	Calibrations pattern	Setup camera	Recommended cameras	Recommended sensors
TCCP3 MHR 144	TCLIB Suite	PTCP-S1-HR1-C	RT-mvBF3-2124aG	COE-123-x-z-080-yy-C, RT-mvBF3-2124aG, RT-mvBF3-2124G, RT-mvBC-X1012b, RT-mvBC-XD1012b	IMX253, IMX304
TCCP3 MHR 192	TCLIB Suite	PTCP-L1-HR1-C	RT-mvBF3-2124aG	COE-123-x-z-080-yy-C, RT-mvBF3-2124aG, RT-mvBF3-2124G, RT-mvBC-X1012b, RT-mvBC-XD1012b	IMX253, IMX304
TCCP5 MHR 144	TCLIB Suite	PTCP-S1-HR1-C	COE29MUSB3IR-F	COE-290-x-z-110-yy-A, COE29xxx, COE50xxx, COE71xxx	KAI-29050, CMV50000, CHR70M
TCCP5 MHR 192	TCLIB Suite	PTCP-L1-HR1-C	COE29MUSB3IR-F	COE-290-x-z-110-yy-A, COE29xxx, COE50xxx, COE71xxx	KAI-29050, CMV50000, CHR70M

1 Since the square shape of the front window the lens forms a rectangular image.
2 Working distance: distance between the front end of the mechanics and the object. Set this distance within +/- 5% of the nominal value for maximum resolution and minimum distortion.
3 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. Typical (average production) values and maximum (guaranteed) values are listed.
4 Maximum slope of chief rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimeter of object displacement. Maximum (guaranteed) values are listed.
5 Percent deviation of the real image compared to an ideal, undistorted image. Maximum (guaranteed) values of the uncorrected image are listed.
6 Residual distortion after calibration with TCLIB Suite software library, using a PTCP calibrations pattern and a fully GenICam® compliant camera. For setup information see related table.
7 At the borders of the field depth the image can be still used for measurement but, to get a very sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 3.45 µm.
8 Indicates the availability of an integrated camera phase adjustment feature.
9 Maximum dimension of the clamping flange.
10 Measured from the front end of the mechanics to the camera flange.

TCDP PLUS series

Dual magnification telecentric lenses

KEY ADVANTAGES

Perfect measurement accuracy
TCDP PLUS telecentric lenses produce two images at different magnifications to cover an extended range of product sizes with the same accuracy.

Revolutionary flexibility
281 possible combinations allow you to personalize and order the TCDP PLUS lens fitting YOUR needs.

Smart cost reduction
Solving two vision tasks with one lens involves less components and lowers the vision system cost.

Off-the-shelf lenses tailored for your needs
Get a standard product customized for your application with no increase in price or lead time.

Detailed test report with measured optical parameters.

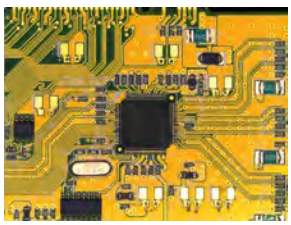
TCDP PLUS series are dual magnification telecentric lenses supporting two cameras to measure objects with different magnifications. They are the perfect choice for measuring components of different sizes but also for applications where an entire sample and some of its smaller features have to be measured with the same accuracy.
The fixed design of these lenses ensures perfect repeatability with no need to recalibrate after each magnification change.

TCDP PLUS lenses help cut the cost of your vision system: you only need to integrate one lens, one illuminator and one mount.

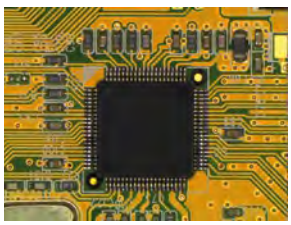
TCDP PLUS lenses are compatible with CMHO clamping mechanics and LTCLHP collimated illuminators, as well as LTRN ring illuminators designed for the standard TC series.

Application examples

TCDP23C4MC096 imaging an electronic board with two different cameras.

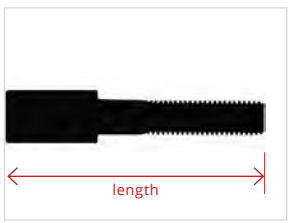


Full FOV image with lens lower magnification.



2x magnified image of the object central area.

TCDP23C4XC144 imaging a screw with two different cameras.



Full FOV image with lens lower magnification.

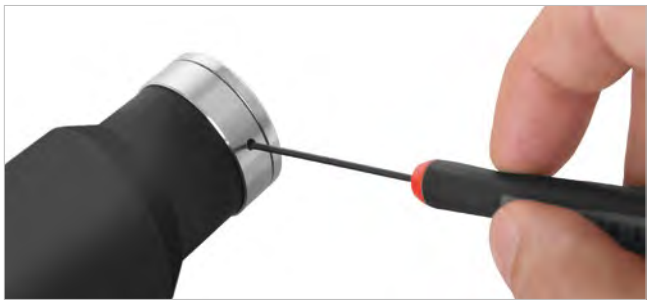
4x magnified image of the object central area.

TCDP23C4XC096 coupled with LTCLHP 096 telecentric illuminator and LTRN 096 NW ring light.

TCDP PLUS revolutionary design can easily meet any of your application needs: 281 possible combinations allow to create the perfect lens for you, also benefiting from the price and lead time of off-the-shelf components.

TCDP PLUS lenses come in 5 different sizes and can be configured with 2 different eyepieces out of the 7 available. They are compatible with several different camera sensors from 1/3" to 4/3" and are available with C-, F- or M42x1 (FD 16mm) camera mounts.

In the tables below you'll find a wide range of TCDP PLUS lenses. On our website you'll find a simple tool that allows you to create and order your own TCDP PLUS lens based on your camera sensor and desired fields of view.



Built-in phase adjustment makes it easy to align the camera sensor.

FOR OTHER MULTI-MAGNIFICATION OPTICS SEE ALSO		
	TCZRS series	p. 38
FULL RANGE OF COMPATIBLE ILLUMINATORS		
	LTCLHP series collimated illuminators	p. 132
FULL RANGE OF COMPATIBLE ACCESSORIES		
	CMHO series	p. 228
FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205
	COE HR AS-X series	p. 207

SETUP

Please check our website for all 281 possible combinations.

www.opto-e.com

TCDP PLUS series

Dual magnification telecentric lenses

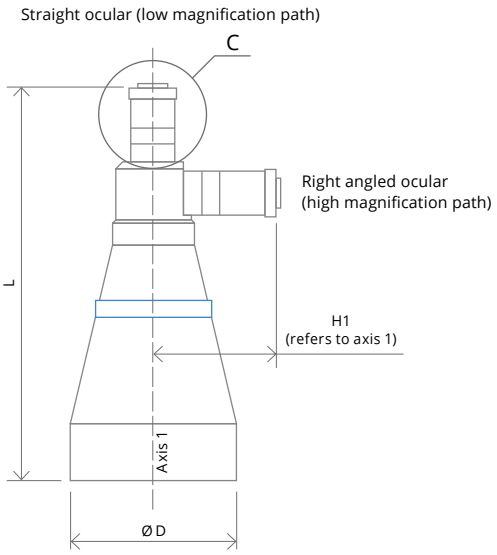
Part number	Mount	Mag. (x)	Image circle Ø (mm)	Detector type: 1/3" 6 mm diag w x h 4.80 x 3.60 (mm x mm)	1/2.5" 7.1 mm diag w x h 5.70 x 4.28 (mm x mm)	1/2" 8 mm diag w x h 6.40 x 4.80 (mm x mm)	1/1.8" 8.9 mm diag w x h 7.13 x 5.33 (mm x mm)	2/3" - 5 Mpx 11.1 mm diag w x h 8.50 x 7.09 (mm x mm)	1/1.2" IMX174 / IMX249 14.8 mm diag w x h 11.3 x 7.10 (mm x mm)	1" IMX255 / IMX267 16 mm diag w x h 14.19 x 7.51 (mm x mm)	1.1" IMX253 / IMX304 21.5 mm diag w x h 14.2 x 10.4 (mm x mm)	4/3" KAI-08050 22.6 mm diag w x h 18.1 x 13.6 (mm x mm)
				Object field of view (mm x mm)								
TCDP 2MF 4MF 096	F	0.137	16.9	35,0 x 26,3	41,6 x 31,2	46,7 x 35,0	52,0 x 38,9	62,0 x 51,8	82,5 x 51,8	103,6 x 54,8	ø = 75,9	ø = 99,3
		0.186	21.6	25,8 x 19,4	30,6 x 23,0	34,4 x 25,8	38,3 x 28,7	45,7 x 38,1	60,8 x 38,2	76,3 x 40,4	76,3 x 55,9	97,3 x 73,1
TCDP 23C 4XC 096	C	0.093	11.0	51,6 x 38,7	61,3 x 46,0	68,8 x 51,6	76,7 x 57,3	91,4 x 76,2	ø = 76,3	ø = 80,8	ø = 111,8	n.a.
		0.374	11.0	12,8 x 9,6	15,2 x 11,4	17,1 x 12,8	19,1 x 14,3	22,7 x 19,0	ø = 19,0	ø = 20,1	ø = 27,8	n.a.
TCDP 23C 4MC096	C	0.093	11.0	51,6 x 38,7	61,3 x 46,0	68,8 x 51,6	76,7 x 57,3	91,4 x 76,2	ø = 76,3	ø = 80,8	ø = 111,8	n.a.
		0.186	21.6	25,8 x 19,4	30,6 x 23,0	34,4 x 25,8	38,3 x 28,7	45,7 x 38,1	60,8 x 38,2	76,3 x 40,4	76,3 x 55,9	97,3 x 73,1
TCDP 12C 23C 096	C	0.068	8.0	70,6 x 52,9	83,8 x 62,9	94,1 x 70,6	ø = 78,4	ø = 104,3	ø = 104,4	ø = 110,4	x	n.a.
		0.093	11.0	51,6 x 38,7	61,3 x 46,0	68,8 x 51,6	76,7 x 57,3	91,4 x 76,2	ø = 76,3	ø = 80,8	ø = 111,8	n.a.
TCDP 2MF 4MF 120	F	0.104	16.5	46,2 x 34,6	54,8 x 41,2	61,5 x 46,2	68,6 x 51,3	81,7 x 68,2	108,7 x 68,3	136,4 x 72,2	ø = 100,0	ø = 130,8
		0.143	21.2	33,6 x 25,2	39,9 x 29,9	44,8 x 33,6	49,9 x 37,3	59,4 x 49,6	79,0 x 49,7	99,2 x 52,5	99,3 x 72,7	126,6 x 95,1
TCDP 23C 4XC 120	C	0.072	11.0	66,7 x 50,0	79,2 x 59,4	88,9 x 66,7	99,0 x 74,0	118,1 x 98,5	ø = 98,6	ø = 104,3	ø = 144,4	n.a.
		0.286	11.0	16,8 x 12,6	19,9 x 15,0	22,4 x 16,8	24,9 x 18,6	29,7 x 24,8	ø = 24,8	ø = 26,3	ø = 36,4	n.a.
TCDP 23C 4MC 120	C	0.072	11.0	66,7 x 50,0	79,2 x 59,4	88,9 x 66,7	99,0 x 74,0	118,1 x 98,5	ø = 98,6	ø = 104,3	ø = 144,4	n.a.
		0.143	21.2	33,6 x 25,2	39,9 x 29,9	44,8 x 33,6	49,9 x 37,3	59,4 x 49,6	79,0 x 49,7	99,2 x 52,5	99,3 x 72,7	126,6 x 95,1
TCDP 12C 23C 120	C	0.052	8.0	92,3 x 69,2	109,6 x 82,3	123,1 x 92,3	ø = 102,5	ø = 136,3	ø = 136,5	ø = 144,4	x	n.a.
		0.072	11.0	66,7 x 50,0	79,2 x 59,4	88,9 x 66,7	99,0 x 74,0	118,1 x 98,5	ø = 98,6	ø = 104,3	ø = 144,4	n.a.
TCDP 2MF 4MF 144	F	0.089	16.8	53,9 x 40,4	64,0 x 48,1	71,9 x 53,9	80,1 x 59,9	95,5 x 79,7	127,0 x 79,8	159,4 x 84,4	ø = 116,9	ø = 152,8
		0.122	21.6	39,3 x 29,5	46,7 x 35,1	52,5 x 39,3	58,4 x 43,7	69,7 x 58,1	92,6 x 58,2	116,3 x 61,6	116,4 x 85,2	148,4 x 111,5
TCDP 23C 4XC 144	C	0.061	11.0	78,7 x 59,0	93,4 x 70,2	104,9 x 78,7	116,9 x 87,4	139,3 x 116,2	ø = 116,4	ø = 123,1	ø = 170,5	n.a.
		0.244	11.0	19,7 x 14,8	23,4 x 17,5	26,2 x 19,7	29,2 x 21,8	34,8 x 29,1	ø = 29,1	ø = 30,8	ø = 42,6	n.a.
TCDP 23C 4MC 144	C	0.061	11.0	78,7 x 59,0	93,4 x 70,2	104,9 x 78,7	116,9 x 87,4	139,3 x 116,2	ø = 116,4	ø = 123,1	ø = 170,5	n.a.
		0.122	21.6	39,3 x 29,5	46,7 x 35,1	52,5 x 39,3	58,4 x 43,7	69,7 x 58,1	92,6 x 58,2	116,3 x 61,6	116,4 x 85,2	148,4 x 111,5
TCDP 12C 23C 144	C	0.044	8.0	109,1 x 81,8	129,5 x 97,3	145,5 x 109,1	ø = 121,1	ø = 161,1	ø = 161,4	ø = 170,7	x	n.a.
		0.061	11.0	78,7 x 59,0	93,4 x 70,2	104,9 x 78,7	116,9 x 87,4	139,3 x 116,2	ø = 116,4	ø = 123,1	ø = 170,5	n.a.
TCDP 2MF 4MF 192	F	0.067	16.8	71,6 x 53,7	85,1 x 63,9	95,5 x 71,6	106,4 x 79,6	126,9 x 105,8	168,7 x 106,0	211,8 x 112,1	ø = 155,2	ø = 203,0
		0.092	21.6	52,2 x 39,1	62,0 x 46,5	69,6 x 52,2	77,5 x 57,9	92,4 x 77,1	122,8 x 77,2	154,2 x 81,6	154,3 x 113,0	196,7 x 147,8
TCDP 23C 4XC 192	C	0.046	11.0	104,3 x 78,3	123,9 x 93,0	139,1 x 104,3	155,0 x 115,9	184,8 x 154,1	ø = 154,3	ø = 163,3	ø = 226,1	n.a.
		0.183	11.0	26,2 x 19,7	31,1 x 23,4	35,0 x 26,2	39,0 x 29,1	46,4 x 38,7	ø = 38,8	ø = 41,0	ø = 56,8	n.a.
TCDP 23C 4MC 192	C	0.046	11.0	104,3 x 78,3	123,9 x 93,0	139,1 x 104,3	155,0 x 115,9	184,8 x 154,1	ø = 154,3	ø = 163,3	ø = 226,1	n.a.
		0.092	21.6	52,2 x 39,1	62,0 x 46,5	69,6 x 52,2	77,5 x 57,9	92,4 x 77,1	122,8 x 77,2	154,2 x 81,6	154,3 x 113,0	196,7 x 147,8
TCDP 12C 23C 192	C	0.033	8.0	145,5 x 109,1	172,7 x 129,7	193,9 x 145,5	ø = 161,5	ø = 214,8	ø = 215,2	ø = 227,6	x	n.a.
		0.046	11.0	104,3 x 78,3	123,9 x 93,0	139,1 x 104,3	155,0 x 115,9	184,8 x 154,1	ø = 154,3	ø = 163,3	ø = 226,1	n.a.
TCDP 2MF 4MF 240	F	0.053	16.2	90,6 x 67,9	107,5 x 80,8	120,8 x 90,6	134,5 x 100,6	160,4 x 133,8	213,2 x 134,0	267,7 x 141,7	ø = 196,2	ø = 256,6
		0.073	21.1	65,8 x 49,3	78,1 x 58,6	87,7 x 65,8	97,7 x 73,0	116,4 x 97,1	154,8 x 97,3	194,4 x 102,9	194,5 x 142,5	247,9 x 186,3
TCDP 23C 4XC 240	C	0.037	11.0	129,7 x 97,3	154,1 x 115,7	173,0 x 129,7	192,7 x 144,1	229,7 x 191,6	ø = 191,9	ø = 203,0	ø = 281,1	n.a.
		0.147	11.0	32,7 x 24,5	38,8 x 29,1	43,5 x 32,7	48,5 x 36,3	57,8 x 48,2	ø = 48,3	ø = 51,1	ø = 70,7	n.a.
TCDP 23C 4MC 240	C	0.037	11.0	129,7 x 97,3	154,1 x 115,7	173,0 x 129,7	192,7 x 144,1	229,7 x 191,6	ø = 191,9	ø = 203,0	ø = 281,1	n.a.
		0.073	21.1	65,8 x 49,3	78,1 x 58,6	87,7 x 65,8	97,7 x 73,0	116,4 x 97,1	154,8 x 97,3	194,4 x 102,9	194,5 x 142,5	247,9 x 186,3
TCDP 23C 2MC 240	C	0.037	11.0	129,7 x 97,3	154,1 x 115,7	173,0 x 129,7	192,7 x 144,1	229,7 x 191,6	ø = 191,9	ø = 203,0	ø = 281,1	n.a.
		0.053	16.2	90,6 x 67,9	107,5 x 80,8	120,8 x 90,6	134,5 x 100,6	160,4 x 133,8	213,2 x 134,0	267,7 x 141,7	ø = 196,2	ø = 256,6

TCDP PLUS lens dimensions:

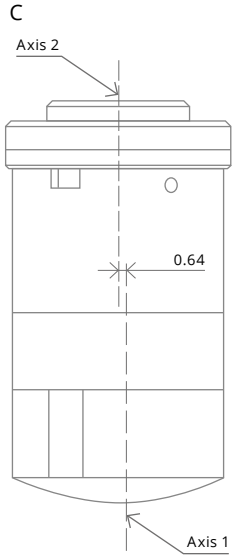
L = length of the lens
from the front end
to its straight ocular
(low magnification path)

H1 = distance from the end
of the right angled ocular
(high magnification path)
to the middle of the lens (axis 1)

D = lens diameter



Dimensions of a TCDP PLUS lens.



Position of axis 1 and axis 2.

		Optical specifications						Mechanical specifications				
Part number	**Mag.** (x)	**WD** (mm)	**F/N** [1]	**Telecentricity** (deg) [2]	**Distortion** typical (max) (%)	**Field depth** (mm) [3]	**CTF** @70lp/mm (%)	**Mount**	**Phase adj.**	**Length** L (mm)	H1 (mm)	**Diam.** D (mm)
TCDP 2MF 4MF 096	0.137	278.6	16.0	< 0.05 (0.10)	< 0.07 (0.10)	70.0	> 40	F	Yes	341.6	117.1	143.0
	0.186	278.6	16.0	< 0.05 (0.10)	< 0.04 (0.10)	38.0	> 35					
TCDP 23C 4XC 096	0.093	278.6	8.0	< 0.06 (0.08)	< 0.04 (0.08)	76.0	> 40	C	Yes	337.7	192.1	143.0
	0.374	278.6	12.0	< 0.06 (0.10)	< 0.07 (0.10)	7.0	> 40					
TCDP 23C 4MC 096	0.093	278.6	8.0	< 0.06 (0.08)	< 0.04 (0.08)	76.0	> 40	C	Yes	337.7	146.0	143.0
	0.186	278.6	16.0	< 0.05 (0.10)	< 0.04 (0.10)	38.0	> 35					
TCDP 12C 23C 096	0.068	278.6	8.0	< 0.06 (0.08)	< 0.03 (0.08)	143.0	> 45	C	Yes	318.0	89.2	143.0
	0.093	278.6	8.0	< 0.06 (0.08)	< 0.04 (0.08)	76.0	> 40					
TCDP 2MF 4MF 120	0.104	334.5	16.0	< 0.07 (0.10)	< 0.07 (0.10)	122.0	> 40	F	Yes	427.3	118.9	180.0
	0.143	334.5	16.0	< 0.05 (0.10)	< 0.04 (0.10)	65.0	> 30					
TCDP 23C 4XC 120	0.072	334.5	8.0	< 0.07 (0.08)	< 0.04 (0.10)	127.0	> 35	C	Yes	423.4	192.1	180.0
	0.286	334.5	12.0	< 0.08 (0.10)	< 0.05 (0.08)	12.0	> 35					
TCDP 23C 4MC 120	0.072	334.5	8.0	< 0.07 (0.08)	< 0.04 (0.10)	127.0	> 35	C	Yes	423.4	147.8	180.0
	0.143	334.5	16.0	< 0.05 (0.10)	< 0.04 (0.10)	65.0	> 30					
TCDP 12C 23C 120	0.052	334.5	8.0	< 0.06 (0.08)	< 0.04 (0.10)	244.0	> 45	C	Yes	403.7	91.1	180.0
	0.072	334.5	8.0	< 0.07 (0.08)	< 0.04 (0.10)	127.0	> 35					
TCDP 2MF 4MF 144	0.089	396.0	16.0	< 0.05 (0.10)	< 0.05 (0.10)	167.0	> 40	F	Yes	486.7	118.9	200.0
	0.122	396.0	16.0	< 0.05 (0.10)	< 0.04 (0.10)	89.0	> 30					
TCDP 23C 4XC 144	0.061	396.0	8.0	< 0.05 (0.08)	< 0.04 (0.08)	177.0	> 40	C	Yes	482.8	192.1	200.0
	0.244	396.0	12.0	< 0.08 (0.10)	< 0.05 (0.08)	17.0	> 35					
TCDP 23C 4MC 144	0.061	396.0	8.0	< 0.05 (0.08)	< 0.04 (0.08)	177.0	> 40	C	Yes	482.8	147.8	200.0
	0.122	396.0	16.0	< 0.05 (0.10)	< 0.04 (0.10)	89.0	> 30					
TCDP 12C 23C 144	0.044	396.0	8.0	< 0.05 (0.08)	< 0.05 (0.08)	341.0	> 35	C	Yes	463.1	91.1	200.0
	0.061	396.0	8.0	< 0.05 (0.08)	< 0.04 (0.08)	177.0	> 40					
TCDP 2MF 4MF 192	0.067	527.0	16.0	< 0.05 (0.10)	< 0.04 (0.10)	294.0	> 40	F	Yes	627.2	118.9	260.0
	0.092	527.0	16.0	< 0.05 (0.10)	< 0.04 (0.10)	156.0	> 30					
TCDP 23C 4XC 192	0.046	527.0	8.0	< 0.06 (0.08)	< 0.05 (0.08)	312.0	> 35	C	Yes	623.2	192.1	260.0
	0.183	527.0	12.0	< 0.08 (0.10)	< 0.05 (0.08)	30.0	> 35					
TCDP 23C 4MC 192	0.046	527.0	8.0	< 0.06 (0.08)	< 0.05 (0.08)	312.0	> 35	C	Yes	623.2	147.8	260.0
	0.092	527.0	16.0	< 0.05 (0.10)	< 0.04 (0.10)	156.0	> 30					
TCDP 12C 23C 192	0.033	527.0	8.0	< 0.06 (0.08)	< 0.04 (0.08)	606.0	> 45	C	Yes	603.5	91.1	260.0
	0.046	527.0	8.0	< 0.06 (0.08)	< 0.05 (0.08)	312.0	> 35					
TCDP 2MF 4MF 240	0.053	492.8	16.0	< 0.05 (0.10)	< 0.04 (0.10)	470.0	> 40	F	Yes	788.8	95.0	322.0
	0.073	492.8	16.0	< 0.05 (0.10)	< 0.04 (0.10)	248.0	> 40					
TCDP 23C 4XC 240	0.037	492.8	8.0	< 0.03 (0.08)	< 0.04 (0.08)	482.0	> 45	C	Yes	784.9	192.1	322.0
	0.147	492.8	12.0	< 0.06 (0.10)	< 0.08 (0.10)	46.0	> 45					
TCDP 23C 4MC 240	0.037	492.8	8.0	< 0.03 (0.08)	< 0.04 (0.08)	482.0	> 45	C	Yes	784.9	147.8	322.0
	0.073	492.8	16.0	< 0.05 (0.10)	< 0.05 (0.10)	248.0	> 30					
TCDP 23C 2MC 240	0.037	492.8	8.0	< 0.03 (0.08)	< 0.04 (0.08)	482.0	> 45	C	Yes	784.9	124.0	322.0
	0.053	492.8	16.0	< 0.05 (0.10)	< 0.04 (0.10)	470.0	> 40					

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

2 Maximum slope of principal rays inside the lens: when converted to milliradians, it gives the maximum measurement error for any millimiter of object displacement.

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

TCCX2M series

Telecentric lenses with built-in coaxial illumination for detectors up to 1"

Part number	Mag.	Image circle	Max detector size	Detector type: 1/3'' 6 mm diag w x h 4.80 x 3.60 (mm x mm)	1/2.5'' 7.1 mm diag w x h 5.70 x 4.28 (mm x mm)	1/2'' 8 mm diag w x h 6.4 x 4.8 (mm x mm)	1/1.8'' 8.9 mm diag w x h 7.13 x 5.33 (mm x mm)	2/3'' 5 MP 11 mm diag w x h 8.50 x 7.09 (mm x mm)	1" - IMX255/267 16.1 mm diag w x h 14.19 x 7.51 (mm x mm)	Optical specifications: WD	wF/# [1]	Distortion typical	Field depth	Nominal resolving power	Mechanical specs: Mount	Phase adj. [2]	Length	Diam.
	(x)	Ø (mm)		Object field of view (mm x mm)						(mm)		(%)	(mm)	(µm)			(mm)	(mm)
RT-MP-4F-65	4.00	16	1"	1.20 x 0.90	1.43 x 1.07	1.60 x 1.20	1.78 x 1.33	2.13 x 1.77	3.55 x 1.88	65.00	16.7	0.23	0.04	2.80	C	Yes	166	29
RT-MP-2F-65	2.00	16	1"	2.40 x 1.80	2.85 x 2.14	3.20 x 2.40	3.57 x 2.67	4.25 x 3.55	7.10 x 3.76	65.00	10	0.40	0.10	3.40	C	Yes	127	29
RT-MP-1.5F-65	1.50	16	1"	3.20 x 2.40	3.80 x 2.85	4.27 x 3.20	4.75 x 3.55	5.67 x 4.73	9.46 x 5.01	65.00	7.5	0.50	0.11	3.40	C	Yes	115	29
RT-MP-1F-65	1.00	16	1"	4.80 x 3.60	5.70 x 4.28	6.40 x 4.80	7.13 x 5.33	8.50 x 7.09	14.19 x 7.51	65.50	8	-0.10	0.28	5.40	C	Yes	133	32
RT-TCL0750-FU	0.75	16	1"	6.40 x 4.80	7.60 x 5.71	8.53 x 6.40	9.51 x 7.11	11.33 x 9.45	18.92 x 10.01	60.70	12 - 60	-0.03	0.80	11.00	C		206	38
RT-TCL0600-FU	0.60	16	1"	8.00 x 6.00	9.50 x 7.13	10.7 x 8.00	11.9 x 8.88	14.2 x 11.8	23.7 x 12.5	78.50	12 - 60	-0.02	1.30	13.50	C		229	44
RT-TCL0450-FU	0.45	16	1"	10.7 x 8.00	12.7 x 9.51	14.2 x 10.7	15.8 x 11.8	18.9 x 15.8	31.5 x 16.7	108.20	12 - 60	0.01	2.20	18.00	C		265	49
RT-TCL0300-FU	0.30	16	1"	16.0 x 12.0	19.0 x 14.3	21.3 x 16.0	23.8 x 17.8	28.3 x 23.6	47.3 x 25.0	167.00	12 - 60	0.01	5.00	27.00	C		338	68

1 Working F-number (wF/#): the real F-number of a lens when used as a macro.
2 Indicates the availability of an integrated camera phase adjustment feature.

FULL RANGE OF COMPATIBLE LED SOURCES

LDSC series p. 267

FULL RANGE OF COMPATIBLE POWER SUPPLIES

RT-PSP-12122-LV-xx power supply p. 260

FULL RANGE OF COMPATIBLE CAMERAS

Area scan cameras p. 196-205

Did you know that our telecentric lenses and illuminators are delivered with their own optical test report proving that all the performance standards declared are met?
We have the perfect solution for all your measurement applications!

TC12M series

High resolution telecentric lenses for up to APS-H sensors

NEW

TC12M high resolution telecentric lenses designed for detectors with up to 33.5mm image circle. They perfectly fit cameras with large sensors, up to APS-H sensor format.

TC12M series lenses feature a compact and robust design that makes them ideal for variouos industrial applications.

To help you pick the right lens, we listed some of the most popular area scan sensors in the matrix chart below: just choose the column with your camera sensor and scroll down the table until you find the field of view that best matches your application, then scroll left to find the lens part number.

KEY ADVANTAGES

Wide image circle suitable APS-H type sensors.

Excellent resolution and low distortion.

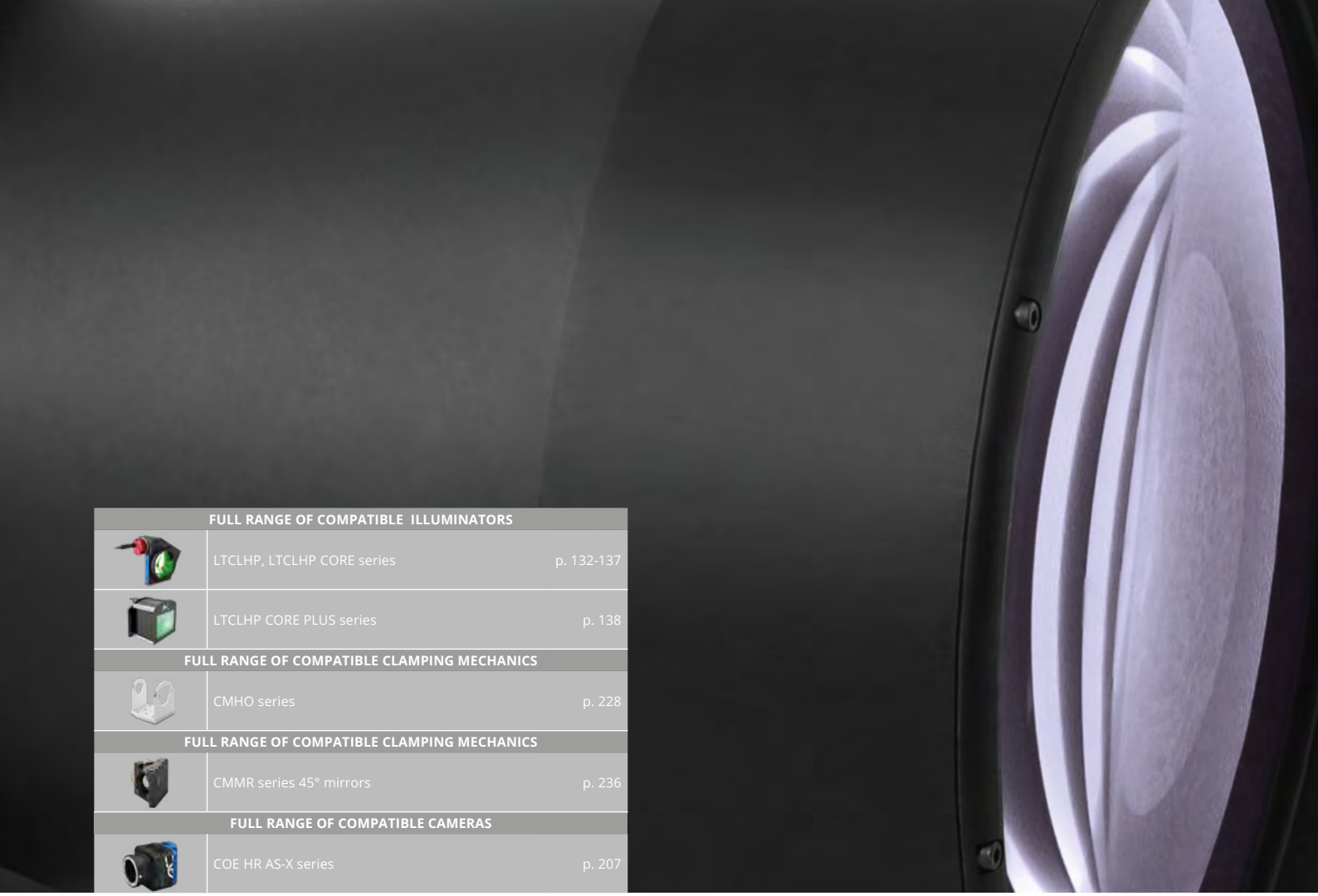
Simple and robust design for industrial environments.

Detailed test report with certified 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-e.com/faqs

Mount F



FULL RANGE OF COMPATIBLE ILLUMINATORS		
	LTCLHP, LTCLHP CORE series	p. 132-137
	LTCLHP CORE PLUS series	p. 138
FULL RANGE OF COMPATIBLE CLAMPING MECHANICS		
	CMHO series	p. 228
FULL RANGE OF COMPATIBLE CLAMPING MECHANICS		
	CMMR series 45° mirrors	p. 236
FULL RANGE OF COMPATIBLE CAMERAS		
	COE HR AS-X series	p. 207

			Detector type					Optical specifications						Mechanical specifications			
Part number	**Mag.** (x)	**Image circle** Ø (mm)	**PYTHON 16K 26.07 mm diag** w x h 18.43 x 18.43 (mm x mm)	**APS-C CMV12000 28.16 mm diag** w x h 22.53 x 16.90 (mm x mm)	**Line -4k 4k x 7 µm** w 28.67 (mm)	**APS-H PYTHON 32.58 mm diag** w x h 23.4 x 23.04 (mm x mm)	**APS-H KAI-16050 32.4 mm diag** w x h 26.93 x 17.95 (mm x mm)	**WD** (mm) 1	**wF/#** 2	**Telecentricity** typical (max) (deg) 3	**Distortion** typical (max) (%) 4	**Field Depth** (mm) 5	**CTF** @50lp/mm (%)	**Mount** 6	**Phase adj.** 8	**Length** (mm) 7	**Diam.** (mm)
			Object field of view (mm)														
TC12M 016-F	1.918	33.5	9.61 x 9.61	11.75 x 8.81	14.95	12.01 x 12.01	14.04 x 9.36	42.0	17	<0.08 (0.10)	<0.08 (0.10)	0.4	> 40	F	Yes	218.0	64
TC12M 024-F	1.145	33.5	16.10 x 16.10	19.68 x 14.76	25.04	20.12 x 20.12	23.52 x 15.68	58.0	16	<0.08 (0.10)	<0.08 (0.10)	1.0	> 45	F	Yes	212.6	64
TC12M 036-F	0.839	33.5	21.97 x 21.97	26.85 x 20.14	34.17	27.46 x 27.46	32.10 x 21.40	94.9	11	<0.08 (0.10)	<0.08 (0.10)	1.3	> 40	F	Yes	284.8	64
TC12M 048-F	0.576	33.5	32.00 x 32.00	39.11 x 29.33	49.77	40.00 x 40.00	46.75 x 31.17	92.6	10	<0.08 (0.10)	<0.08 (0.10)	2.5	> 55	F	Yes	268.8	75
TC12M 056-F	0.531	33.5	34.71 x 34.71	42.43 x 31.82	53.99	43.39 x 43.39	50.71 x 33.81	136.5	11	<0.08 (0.10)	<0.08 (0.10)	3.2	> 55	F	Yes	331.7	82
TC12M 064-F	0.465	33.5	39.64 x 39.64	48.45 x 36.34	61.66	49.55 x 49.55	57.91 x 38.61	157.6	11	<0.08 (0.10)	<0.08 (0.10)	4.2	> 55	F	Yes	353.5	100
TC12M 080-F	0.376	33.5	49.02 x 49.02	59.91 x 44.94	76.25	61.28 x 61.28	71.62 x 47.74	199	11	<0.08 (0.10)	<0.08 (0.10)	6.4	> 50	F	Yes	401.2	116
TC12M 096-F	0.306	33.5	60.24 x 60.24	73.62 x 55.22	93.69	75.29 x 75.29	88.00 x 58.67	256	8	<0.08 (0.10)	<0.08 (0.10)	7.0	> 55	F	Yes	423..7	143
TC12M 120-F	0.233	33.5	79.11 x 79.11	96.69 x 72.52	123.05	98.88 x 98.88	115.57 x 77.05	303.9	8	<0.08 (0.10)	<0.08 (0.10)	12.2	> 55	F	Yes	508.7	180
TC12M 144-F	0.196	33.5	94.04 x 94.04	114.94 x 86.20	146.28	117.55 x 117.55	137.39 x 91.59	358.5	8	<0.08 (0.10)	<0.08 (0.10)	17.2	> 55	F	Yes	564.2	200
TC12M 192-F	0.144	33.5	128.00 x 128.00	156.44 x 117.33	199.10	160.00 x 160.00	187.00 x 124.67	475.9	8	<0.08 (0.10)	<0.08 (0.10)	31.8	> 50	F	Yes	700.2	260
TC12M 240-F	0.115	33.5	160.28 x 160.28	195.90 x 146.92	249.30	200.35 x 200.35	234.16 x 156.10	542.8	8	<0.08 (0.10)	<0.08 (0.10)	49.9	> 55	F	Yes	849.8	322

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/#: the real F/# 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 very sharp image, only half of the nominal field depth should be considered. Pixel size used for calculation is 5.5 µm.
6 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.
7 Measured from the front end of the mechanics to the camera flange.

TC16M series

Telecentric lenses for 45.72 mm and 8 k pixel line detectors

TC16M series telecentric lenses have been specifically designed to fit 45 mm format (36 x 24 mm) detectors with very high resolution, such as 11, 16 or 29 Mpix.
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 measure 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 certified optical parameters.

Mount F

Mount Q = M58x0.75

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-e.com/faqs

FULL RANGE OF COMPATIBLE ILLUMINATORS		
	LTCLHP, LTCLHP CORE series	p. 132-137
	LTCLHP CORE PLUS series	p. 138
FULL RANGE OF COMPATIBLE CLAMPING MECHANICS		
	CMHO series	p. 228
FULL RANGE OF COMPATIBLE CLAMPING MECHANICS		
	CMMR series 45° mirrors	p. 236
FULL RANGE OF COMPATIBLE CAMERAS		
	HR Area scan cameras	p. 206-209

			Detector type					Optical specifications						Mechanical specifications			
			APS-H KAI-16050	CHR70M	Line 8k	Full frame 35 mm	CMV50000										
			32.4 mm diag	38 mm diag	8k x 5 µm	43.3 mm diag	45.72 mm diag										
Part number	Mag.	Image circle	w x h	w x h	w	w x h	w x h	WD	wF/#	Telecentricity typical (max)	Distortion typical (max)	Field Depth	CTF @50lp/mm	Mount	Phase adj.	Length	Diam.
	(x)	Ø (mm)	26.93 x 17.95 (mm x mm)	31.0 x 21.99 (mm x mm)	40.80 (mm)	36.0 x 24.0 (mm x mm)	36.43 x 27.62 (mm x mm)	(mm)		(deg)	(%)	(mm)	(%)			(mm)	(mm)
								1	2	3	4	5		6	7	8	
			Object field of view (mm)														
TC16M 009	4.00	43.3	6.73 x 4.49	7.75 x 5.50	10.20	9.00 x 6.00	9.11 x 6.90	57.8	22	< 0.03 (0.05)	< 0.03 (0.05)	0.1	> 20	F	Yes	487.9	64
TC16M 009-Q	4.00	43.3	6.73 x 4.49	7.75 x 5.50	10.20	9.00 x 6.00	9.11 x 6.90	57.8	22	< 0.03 (0.05)	< 0.03 (0.05)	0.1	> 20	M58X0.75 FD 6.56	Yes	527.9	64
TC16M 009-K	4.00	43.3	6.73 x 4.49	7.75 x 5.50	10.20	9.00 x 6.00	9.11 x 6.90	57.8	22	< 0.03 (0.05)	< 0.03 (0.05)	0.1	> 20	M58x0.75 FD 12.96	Yes	521.5	64
TC16M 012	3.00	43.3	8.98 x 5.98	10.33 x 7.33	13.60	12.00 x 8.00	12.14 x 9.21	57.8	18	< 0.03 (0.05)	< 0.03 (0.05)	0.2	> 30	F	Yes	378.7	64
TC16M 012-Q	3.00	43.3	8.98 x 5.98	10.33 x 7.33	13.60	12.00 x 8.00	12.14 x 9.21	57.8	18	< 0.03 (0.05)	< 0.03 (0.05)	0.2	> 30	M58X0.75 FD 6.56	Yes	418.7	64
TC16M 012-K	3.00	43.3	8.98 x 5.98	10.33 7.33	13.60	12.00 x 8.00	12.14 x 9.21	57.8	18	< 0.03 (0.05)	< 0.03 (0.05)	0.2	> 30	M58x0.75 FD 12.96	Yes	412.3	64
TC16M 018	2.00	43.3	13.46 x 8.98	15.50 x 11.00	20.40	18.00 x 12.00	18.22 x 13.81	57.8	16	< 0.03 (0.05)	< 0.03 (0.05)	0.3	> 40	F	Yes	259.6	64
TC16M 018-Q	2.00	43.3	13.46 x 8.98	15.50 x 11.00	20.40	18.00 x 12.00	18.22 x 13.81	57.8	16	< 0.03 (0.05)	< 0.03 (0.05)	0.3	> 40	M58X0.75 FD 6.56	Yes	299.5	64
TC16M 018-K	2.00	43.3	13.46 x 8.98	15.50 x 11.00	20.40	18.00 x 12.00	18.22 x 13.81	57.8	16	< 0.03 (0.05)	< 0.03 (0.05)	0.3	> 40	M58x0.75 FD 12.96	Yes	293.1	64
TC16M 036	1.00	42	26.93 x 17.95	31.00 x 21.99	40.80	36.00 x 24.00	36.43 x 27.62	102.6	16	< 0.03 (0.05)	< 0.02 (0.03)	1.3	> 30	F	Yes	309.0	64
TC16M 036-Q	1.00	43.3	26.93 x 17.95	31.00 x 21.99	40.80	36.00 x 24.00	36.43 x 27.62	102.6	16	< 0.03 (0.05)	< 0.02 (0.03)	1.3	> 30	M58X0.75 FD 6.56	Yes	348.9	64
TC16M 036-K	1.00	43.3	26.93 x 17.95	31.00 x 21.99	40.80	36.00 x 24.00	36.43 x 27.62	102.6	16	< 0.03 (0.05)	< 0.02 (0.03)	1.3	> 30	M58x0.75 FD 12.96	Yes	342.6	64
TC16M 048	0.75	43.3	35.90 x 23.94	41.33 x 29.32	54.40	48.00 x 32.00	48.58 x 36.82	125.6	16	< 0.06 (0.10)	< 0.05 (0.10)	2.3	> 30	F	Yes	315.2	75
TC16M 048-Q	0.75	43.3	35.90 x 23.94	41.33 x 29.32	54.40	48.00 x 32.00	48.58 x 36.82	125.6	16	< 0.06 (0.10)	< 0.05 (0.10)	2.3	> 30	M58X0.75 FD 6.56	Yes	355.2	75
TC16M 048-K	0.75	43.3	35.90 x 23.94	41.33 x 29.32	54.40	48.00 x 32.00	48.58 x 36.82	125.6	16	< 0.06 (0.10)	< 0.05 (0.10)	2.3	> 30	M58x0.75 FD 12.96	Yes	348.9	75
TC16M 056	0.64	43.3	42.01 x 28.01	48.36 x 34.31	63.65	56.16 x 37.44	56.84 x 43.09	148.6	16	< 0.04 (0.08)	< 0.04 (0.10)	3.2	> 40	F	Yes	338.5	80
TC16M 056-Q	0.64	43.3	42.01 x 28.01	48.36 x 34.31	63.65	56.16 x 37.44	56.84 x 43.09	148.6	16	< 0.04 (0.08)	< 0.04 (0.10)	3.2	> 40	M58X0.75 FD 6.56	Yes	378.5	80
TC16M 056-K	0.64	43.3	42.01 x 28.01	48.36 x 34.31	63.65	56.16 x 37.44	56.84 x 43.09	148.6	16	< 0.04 (0.08)	< 0.04 (0.10)	3.2	> 40	M58x0.75 FD 12.96	Yes	372.2	80
TC16M 064	0.56	43.3	48.00 x 32.00	55.26 x 39.20	72.73	64.17 x 42.78	64.94 x 49.23	170.6	16	< 0.04 (0.08)	< 0.06 (0.15)	4.2	> 30	F	Yes	359.6	100
TC16M 064-Q	0.56	43.3	48.00 x 32.00	55.26 x 39.20	72.73	64.17 x 42.78	64.94 x 49.23	170.6	16	< 0.04 (0.08)	< 0.06 (0.15)	4.2	> 30	M58X0.75 FD 6.56	Yes	399.6	100
TC16M 064-K	0.56	43.3	48.00 x 32.00	55.26 x 39.20	72.73	64.17 x 42.78	64.94 x 49.23	170.6	16	< 0.04 (0.08)	< 0.06 (0.15)	4.2	> 30	M58x0.75 FD 12.96	Yes	393.3	100
TC16M 080	0.46	43.3	58.16 x 38.77	66.95 x 47.50	88.12	77.75 x 51.84	78.69 x 59.65	197.3	16	< 0.03 (0.08)	< 0.09 (0.20)	6.2	> 30	F	Yes	406.4	116
TC16M 080-Q	0.46	43.3	58.16 x 38.77	66.95 x 47.50	88.12	77.75 x 51.84	78.69 x 59.65	197.3	16	< 0.03 (0.08)	< 0.09 (0.20)	6.2	> 30	M58X0.75 FD 6.56	Yes	446.4	116
TC16M 080-K	0.46	43.3	58.16 x 38.77	66.95 x 47.50	88.12	77.75 x 51.84	78.69 x 59.65	197.3	16	< 0.03 (0.08)	< 0.09 (0.20)	6.2	> 30	M58x0.75 FD 12.96	Yes	440.1	116
TC16M 096	0.38	43.3	70.86 x 47.24	81.58 x 57.87	107.37	94.74 x 63.16	95.87 x 72.68	262.3	16	< 0.06 (0.08)	< 0.07 (0.15)	9.1	> 40	F	Yes	449.2	143
TC16M 096-Q	0.38	43.3	70.86 x 47.24	81.58 x 57.87	107.37	94.74 x 63.16	95.87 x 72.68	262.3	16	< 0.06 (0.08)	< 0.07 (0.15)	9.1	> 40	M58X0.75 FD 6.56	Yes	489.1	143
TC16M 096-K	0.38	43.3	70.86 x 47.24	81.58 x 57.87	107.37	94.74 x 63.16	95.87 x 72.68	262.3	16	< 0.06 (0.08)	< 0.07 (0.15)	9.1	> 40	M58x0.75 FD 12.96	Yes	482.8	143
TC16M 120	0.29	43.3	93.18 x 62.12	107.27 x 76.09	141.18	124.57 x 83.04	126.06 x 95.56	331.6	16	< 0.05 (0.08)	< 0.05 (0.10)	15.8	> 40	F	Yes	538.1	180
TC16M 120-Q	0.29	43.3	93.18 x 62.12	107.27 x 76.09	141.18	124.57 x 83.04	126.06 x 95.56	331.6	16	< 0.05 (0.08)	< 0.05 (0.10)	15.8	> 40	M58X0.75 FD 6.56	Yes	578.1	180
TC16M 120-K	0.29	43.3	93.18 x 62.12	107.27 x 76.09	141.18	124.57 x 83.04	126.06 x 95.56	331.6	16	< 0.05 (0.08)	< 0.05 (0.10)	15.8	> 40	M58x0.75 FD 12.96	Yes	571.8	180
TC16M 144	0.25	43.3	109.91 x 73.27	126.53 x 89.76	166.53	146.94 x 97.96	148.70 x 112.73	397.4	16	< 0.05 (0.08)	< 0.08 (0.20)	22.0	> 40	F	Yes	597.8	200
TC16M 144-Q	0.25	43.3	109.91 x 73.27	126.53 x 89.76	166.53	146.94 x 97.96	148.70 x 112.73	397.4	16	< 0.05 (0.08)	< 0.08 (0.20)	22.0	> 40	M58X0.75 FD 6.56	Yes	637.7	200
TC16M 144-K	0.25	43.3	109.91 x 73.27	126.53 x 89.76	166.53	146.94 x 97.96	148.70 x 112.73	397.4	16	< 0.05 (0.08)	< 0.08 (0.20)	22.0	> 40	M58x0.75 FD 12.96	Yes	631.4	200
TC16M 192	0.19	43.3	144.00 x 96.00	165.78 x 117.60	218.18	192.51 x 128.34	194.82 x 147.69	457.5	16	< 0.06 (0.08)	< 0.05 (0.10)	37.7	> 40	F	Yes	742.0	260
TC16M 192-Q	0.19	43.3	144.00 x 96.00	165.78 x 117.60	218.18	192.51 x 128.34	194.82 x 147.69	457.5	16	< 0.06 (0.08)	< 0.05 (0.10)	37.7	> 40	M58X0.75 FD 6.56	Yes	781.5	260
TC16M 192-K	0.19	43.3	144.00 x 96.00	165.78 x 117.60	218.18	192.51 x 128.34	194.82 x 147.69	457.5	16	< 0.06 (0.08)	< 0.05 (0.10)	37.7	> 40	M58x0.75 FD 12.96	Yes	775.1	260
TC16M 240	0.15	43.3	179.52 x 119.68	206.67 x 146.61	272.00	240.00 x 160.00	242.88 x 184.12	542.8	16	< 0.06 (0.08)	< 0.08 (0.15)	58.7	> 40	F	Yes	899.0	322
TC16M 240-Q	0.15	43.3	179.52 x 119.68	206.67 x 146.61	272.00	240.00 x 160.00	242.88 x 184.12	542.8	16	< 0.06 (0.08)	< 0.08 (0.15)	58.7	> 40	M58X0.75 FD 6.56	Yes	938.7	322
TC16M 240-K	0.15	43.3	179.52 x 119.68	206.67 x 146.61	272.00	240.00 x 160.00	242.88 x 184.12	542.8	16	< 0.06 (0.08)	< 0.08 (0.15)	58.7	> 40	M58x0.75 FD 12.96	Yes	932.3	322

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/#: the real F/# 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 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.
7 Indicates the availability of an integrated camera phase adjustment feature.
8 Measured from the front end of the mechanics to the camera flange.

TC4K series

Flat telecentric lenses for 4 k pixel linescan cameras

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.

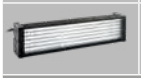
Dedicated CMMR4K mirrors
90° right angle attachment for easy integration in tight spaces.

Detailed test report with measured optical parameters.

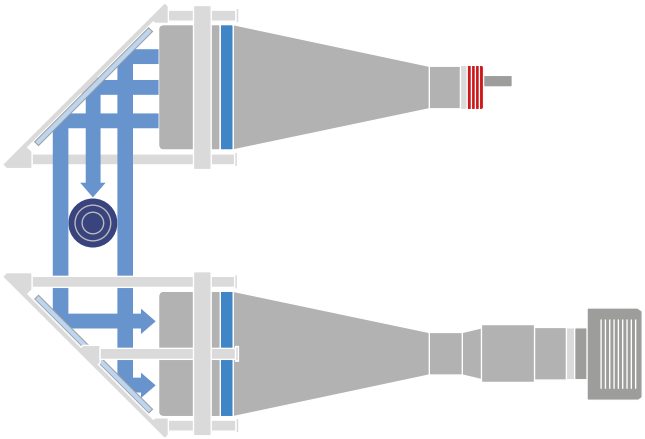
TC4K series telecentric lenses have been designed for measurement applications using linescan cameras with detectors up to 28.7 mm (e.g. 4096 pixels with pixel size 7 µm).
Dimensional constraints are often a major issue when designing line scan systems where the sample or the camera itself must be moved: 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 the user to precisely position the linear FOV at 90° from the object movement direction.

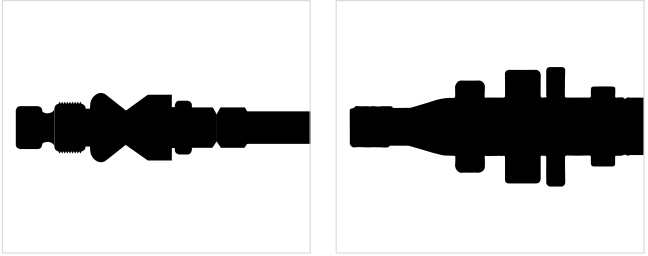
Mount F

Mount N = M42x1

FULL RANGE OF COMPATIBLE ILLUMINATORS		
	LTCL4K series	p. 140
	LTBRDC series	p. 171
FULL RANGE OF COMPATIBLE MIRRORS		
	CMMR4K series	p. 238

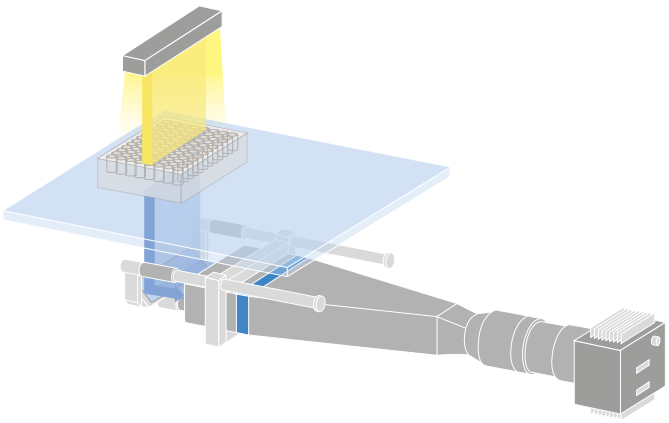
Application examples

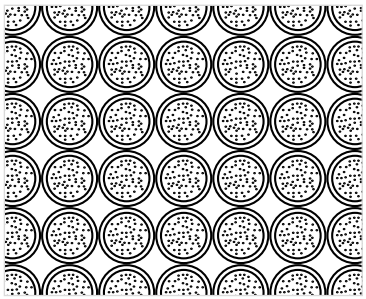




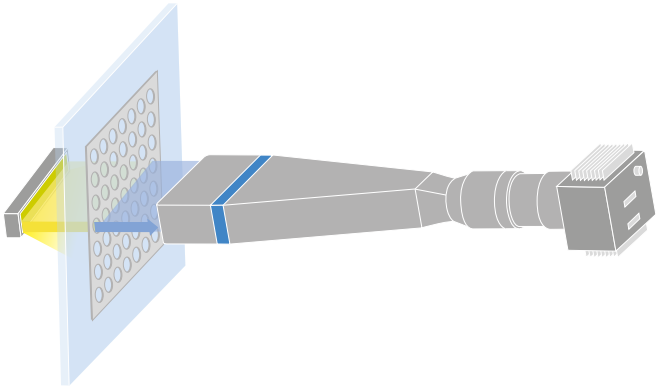
Engine shaft measurement performed with TC4K lens coupled to LTCL4K telecentric illuminator by means of two CMMR4K deflecting mirrors.

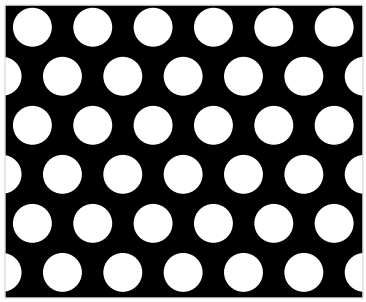
Cell count in a Petri dish performed with TC4K lens used in combination with CMMR4K deflecting mirror and a back light.





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





			Detector type		Optical specifications						Mechanical specifications				
Part number	**Mag.**	**Image circle**	**Line - 2 kpx 2k x 10 µm w** 20.5	**Line - 4 kpx 4k x 7 µm w** 28.7	**WD**	**wF/#**	**Telecentricity** typical (max)	**Distortion** typical (max)	**Field depth**	**CTF** @50lp/mm	**Mount**	**Phase adj.**	**Length**	**Width**	**Height**
	(x)	Ø (mm)	(mm)	(mm)	(mm)		(deg)	(%)	(mm)	(%)			(mm)	(mm)	(mm)
			Object field of view (mm)		1	2	3	4	5			6	7		
TC4K 060-F	0.478	28.7	42.89	60.04	174.0	16	< 0.06 (0.10)	< 0.05 (0.08)	7.4	>30	F	Yes	319,2	83	64
TC4K 060-N	0.478	28.7	42.89	60.04	174.0	16	< 0.06 (0.10)	< 0.05 (0.08)	7.4	>30	M42X1 FD 10.6	Yes	355,2	83	52
TC4K 090-F	0.319	28.7	64.26	89.97	174.0	16	< 0.05 (0.10)	< 0.05 (0.08)	16.5	>30	F	Yes	360,7	114	64
TC4K 090-N	0.319	28.7	64.26	89.97	174.0	16	< 0.05 (0.10)	< 0.05 (0.08)	16.5	>30	M42X1 FD 10.6	Yes	396,6	114	52
TC4K 120-F	0.240	28.7	85.42	119.58	174.0	16	< 0.10 (0.12)	< 0.08 (0.10)	29.2	>25	F	Yes	337,3	144	64
TC4K 120-N	0.240	28.7	85.42	119.58	174.0	16	< 0.10 (0.12)	< 0.08 (0.10)	29.2	>25	M42X1 FD 10.6	Yes	373,2	144	52
TC4K 180-F	0.159	28.7	128.93	180.50	254.0	16	< 0.08 (0.10)	< 0.08 (0.10)	66.5	>30	F	Yes	522,4	208	64
TC4K 180-N	0.159	28.7	128.93	180.50	254.0	16	< 0.08 (0.10)	< 0.08 (0.10)	66.5	>30	M42X1 FD 10.6	Yes	558,4	208	52

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 7 µm
6 Indicates the availability of an integrated camera phase adjustment feature.
7 Measured from the front end of the mechanics to the camera flange.

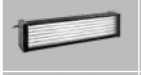
Ordering information

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.

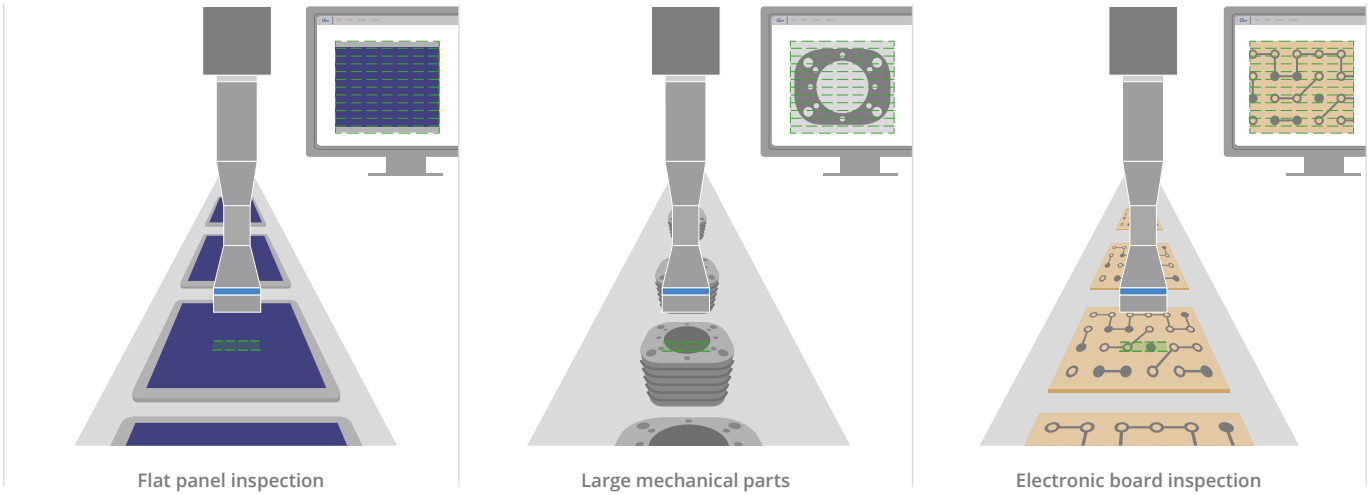
TC12K series

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 very high resolution makes the TC12K series ideal for 12 k and 16 k resolution 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 to accurately measure large mechanical parts.
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.

FULL RANGE OF COMPATIBLE ILLUMINATORS		
	LTBRDC series	p. 171
	LTCLHP CORE series	p. 134
FULL RANGE OF CLAMPING MECHANICS		
	CMHOTC12K series	p. 228
FULL RANGE OF COMPATIBLE CAMERAS		
	COE HR AS series	p. 209
	HR Line scan cameras	p. 210-211

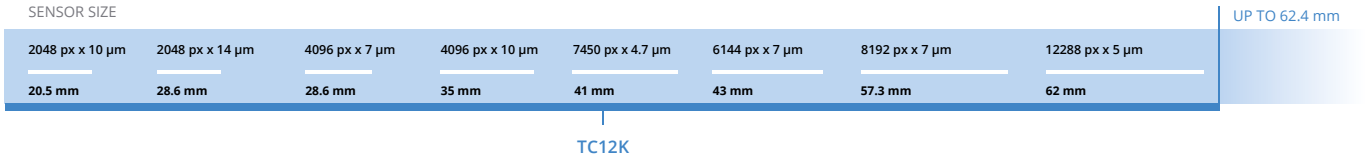
Application examples



Flat panel inspection | Large mechanical parts | Electronic board inspection

Wide image circle

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



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.

			Detector type					Optical specifications						Mechanical specifications			
Part number	**Mag.**	**Image circle**	**KAI-47051 56.7 mm diag. w x h**	**Line - 16k 16k x 3.5 µm w**	**Line - 8k 8k x 7.5 µm w**	**Line - 12k 12k x 5 µm w**	**Line - 12k 12k x 5.2 µm w**	**WD**	**wF/#**	**Telecentricity** typical (max)	**Distortion** typical (max)	**Field depth**	**CTF** @50lp/mm	**Mount**	**Phase adj.**	**Length**	**Diam.**
			48.71 x 29.04	57.3	61.4	61.4	62.4										
	(x)	Ø (mm)	(mm x mm)	(mm)	(mm)	(mm)	(mm)	(mm)		(deg)	(%)	(mm)	(%)			(mm)	(mm)
								1	**2**	**3**	**4**	**5**		**8**	**6**	**7**	
			Object field of view (mm)														
TC12K 064	0.960	62.4	50.74 x 30.25	59.69	63.96	63.96	65.00	162.8	16	< 0.06 (0.08)	< 0.08 (0.10)	1.8	> 35	M72x0.75 FD 6.56	Yes	566.7	100
TC12K 080	0.698	62.4	69.78 x 41.60	82.09	87.97	87.97	89.40	157.4	16	< 0.06 (0.08)	< 0.08 (0.10)	3.4	> 35	M72x0.75 FD 6.56	Yes	541.9	116
TC12K 120	0.529	62.4	92.08 x 54.90	108.32	116.07	116.07	117.96	254	16	< 0.06 (0.08)	< 0.06 (0.08)	6.0	> 40	M72x0.75 FD 6.56	Yes	722.1	180
TC12K 144	0.439	62.4	110.95 x 66.15	130.52	139.86	139.86	142.14	237.9	16	< 0.06 (0.08)	< 0.07 (0.10)	8.7	> 40	M72x0.75 FD 6.56	Yes	743.3	200
TC12K 192	0.320	62.4	152.21 x 90.75	179.06	191.88	191.88	195.00	265.5	16	< 0.06 (0.08)	< 0.08 (0.10)	16.4	> 35	M72x0.75 FD 6.56	Yes	857.5	260
TC12K 240	0.260	62.4	187.34 x 111.69	220.38	236.15	236.15	240.00	492.8	16	< 0.06 (0.08)	< 0.08 (0.10)	24.9	> 35	M72x0.75 FD 6.56	Yes	1072.8	322

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.
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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 7 µm.
6 Indicates the availability of an integrated camera phase adjustment feature.
7 Measured from the front end of the mechanics to the camera flange.
8 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.