



## BI-TELECENTRIC LENSES

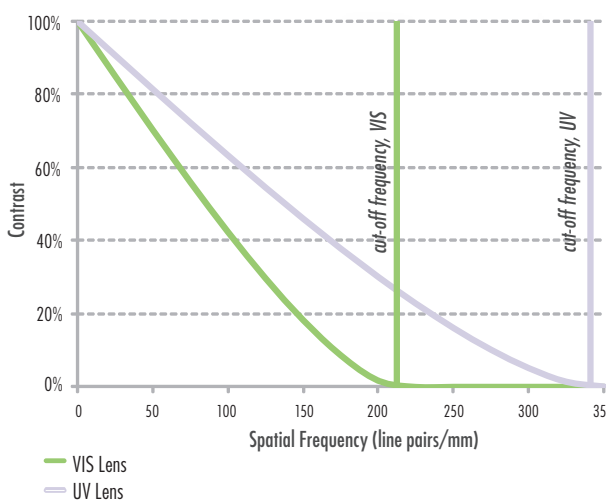
## TCUV SERIES

Opto Engineering® **TC UV 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 TC UV Telecentric Lenses are a **MUST** for all those using high resolution cameras and seeking for the highest possible system accuracy.

Common lenses and traditional telecentric lenses operate in the visible light range. The limiting resolution of a lens is given by the cut-off frequency, the spatial frequency at which the lens is no longer able to yield sufficient image contrast information. As the *cut-off* frequency is inversely proportional to the light wavelength, common telecentric optics are useless with very small pixel sizes (such as 1.75 micron) which are becoming increasingly popular among industrial cameras. **TC UV** bi-telecentric Lenses operate in the 365/425 nm range and deliver much higher image contrast at high spatial frequencies, being therefore compatible with the finest pixel sizes. On the other hand, when used in combination with normal cameras, the resolution of these lenses is so high that they can cope with much larger object displacements (higher field depths) than VIS lenses before any image defocusing becomes evident.

# Ultra-high image resolution, accuracy and field depth



The graph on the left shows the limiting performances (diffraction limit) of two lenses operating at working F-number 8.

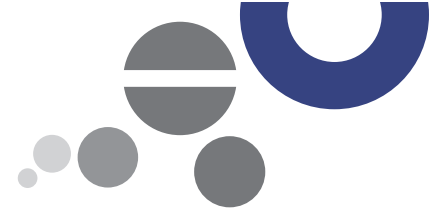
The VIS lens operates at 587 nm (green light) while the UV lens operates at 365 nm.

The MTF function, which expresses the contrast ratio, is much larger at high spatial frequencies in the UV than in the VIS range.

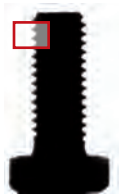
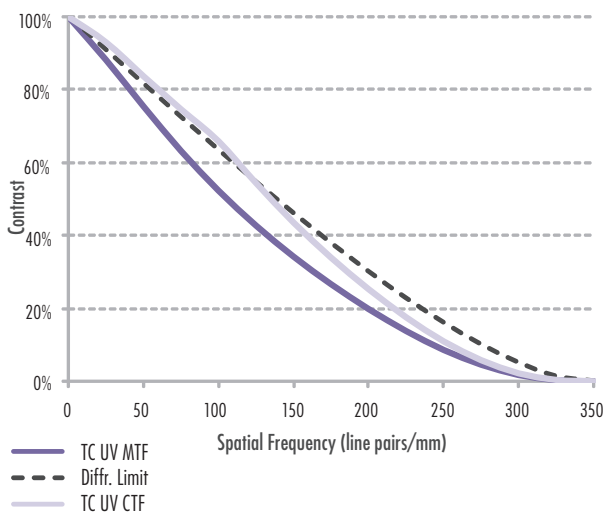
The vertical bars show the cut-off frequencies of both lenses: at 340 lp/mm, contrast yield by TCUV Lenses is still significant and pixels as small as 1.5 microns can bear useful image information.

- 1 The 1/1.8" FOV for TC 12 XX type lenses can show some vignetting at the image corners, as the lens is optimized for 1/2" detector
- 2 Working Distance: distance between the front lens and the object. Set this distance within +/- 3% of the nominal value to optimize distortion and resolution
- 3 Working F-number: the real F-number of a lens when used as a macro. Lenses with smaller apertures can be supplied on request
- 4 Maximum slope of principal rays inside the lens: converted in milliradian, it gives the maximum measurement error for any millimeter of object displacement
- 5 At the borders of the field depth, the image can be still used for measurement, but to get a very sharp image consider half the field depth
- 6 Measured from the end of the mechanics to the camera flange
- 7 For the fields with the indication "diam. =" the image of a circular object is inscribed inside the short side of the detector

part number	magn. (x)	detector type										optical specs						dimensions		
		1/4"		1/3"		1/2"		1/1.8" ①		2/3"		w.d. F/N		telecen- tricity ④	dist.	field depth ⑤	CTF @ 140 lp/mm %	mount	length	diam.
		w x h (mm)	(mm)	w x h (mm)	(mm)	w x h (mm)	(mm)	w x h (mm)	(mm)	w x h (mm)	(mm)	(mm)	(mm)	(deg)	(%)	(mm)			(mm)	(mm)
		object field of view (mm x mm) ⑦																		
TCUV1236	0,175	20,5 x 15,4		27,4 x 20,5		36,5 x 27,4		40,6 x 30,6		diam. = 37,6	98,7	8	<0,1	<0,08	21,0	>40	C	142,3	61,0	
TCUV2336	0,241	14,9 x 11,2		19,9 x 14,9		26,6 x 19,9		29,6 x 22,3		36,5 x 27,4	98,7	8	<0,1	<0,08	11,0	>40	C	160,4	61,0	
TCUV1248	0,133	27,0 x 20,2		36,0 x 27,0		47,9 x 36,0		53,4 x 40,2		diam. = 49,4	130,7	8	<0,08	<0,08	37,0	>40	C	176,1	75,0	
TCUV2348	0,183	19,6 x 14,7		26,2 x 19,6		34,9 x 26,2		38,9 x 29,3		48,0 x 36,0	130,7	8	<0,08	<0,08	20,0	>40	C	160,4	75,0	
TCUV1256	0,114	31,5 x 23,6		42,0 x 31,5		56,1 x 42,0		62,4 x 47,0		diam. = 57,8	154,0	8	<0,1	<0,08	51,0	>40	C	198,4	80,0	
TCUV2356	0,157	22,9 x 17,2		30,6 x 22,9		40,8 x 30,6		45,4 x 34,2		56,1 x 42,1	154,0	8	<0,1	<0,08	27,0	>40	C	160,4	80,0	
TCUV1264	0,100	36,0 x 27,0		48,0 x 36,0		64,0 x 48,0		71,3 x 53,7		diam. = 66,0	176,0	8	<0,08	<0,08	66,0	>40	C	219,7	100,0	
TCUV2364	0,137	26,2 x 19,7		34,9 x 26,2		46,6 x 34,9		51,9 x 39,1		64,1 x 48,0	176,0	8	<0,08	<0,08	35,0	>40	C	160,4	100,0	
TCUV1280	0,080	44,8 x 33,6		59,8 x 44,8		79,7 x 59,8		88,8 x 66,9		diam. = 82,2	221,0	8	<0,08	<0,08	102,0	>40	C	264,3	116,0	
TCUV2380	0,110	32,6 x 24,4		43,5 x 32,6		58,0 x 43,5		64,5 x 48,6		79,7 x 59,8	221,0	8	<0,08	<0,08	54,0	>40	C	160,4	116,0	



## TCUV SERIES



Images of a back illuminated object: on the left the image is captured with a lens operating in the visible range, on the right the same image is taken with a TC UV Telecentric lens.



part number	beam diameter (mm)	mechanical specs		compatible lenses	
		length (mm)	outer diameter (mm)	TCUV 12xx xx=	TCUV 23xx xx=
LTCLUV36	45	138,9	61	36	36
LTCLUV48	60	174,0	75	48	48
LTCLUV56	70	197,3	80	56	56
LTCLUV64	80	219,5	100	64	64
LTCLUV80	100	264,2	116	80	80



optical specs	
wavelength range	405 +/-20 nm FWHM
divergence angle	< +/- 0,5°
optical output	> 40 mW
eye safety class	class IIIb LED product

device power rating	
input voltage	12.. 24 V DC
minimum DC voltage	12 volt
maximum DC voltage	24 volt
power consumption	< 2 watt

led power rating	
forward voltage	3,7 volt
forward current	350 mA

## BI-TELECENTRIC LENSES

The graph shows the resolution specifications of TC UV lenses.

In addition to the MTF diffraction limit, both the MTF curve of TC UV lenses and the CTF (Contrast Transfer Function) curve are displayed.

MTF curve refers to the response of the lens to a sinusoidal pattern, while the CTF function expresses the contrast the lens is yielding when a "square wave" pattern made of black and white stripes is imaged.

If  $w$  is the spatial frequency and  $p$  is the pixel size, then a pixel whose size is  $p = 1/2w$  will yield a contrast given by the CTF at the spatial frequency  $w$ .

Opto Engineering® offers a wide range of TCUV-compatible illuminators, such as UV collimated, ring, coaxial and back lights. For high accuracy measurement applications **LT CL UV Collimated Illuminators** are the products of choice due to superior image resolution and field depth enhancement.

These Telecentric Illuminators ensure an extremely efficient optical coupling with **UV Telecentric Lenses, making UV enhanced detectors not necessary;** this allows for any CCD or CMOS camera to be integrated.

