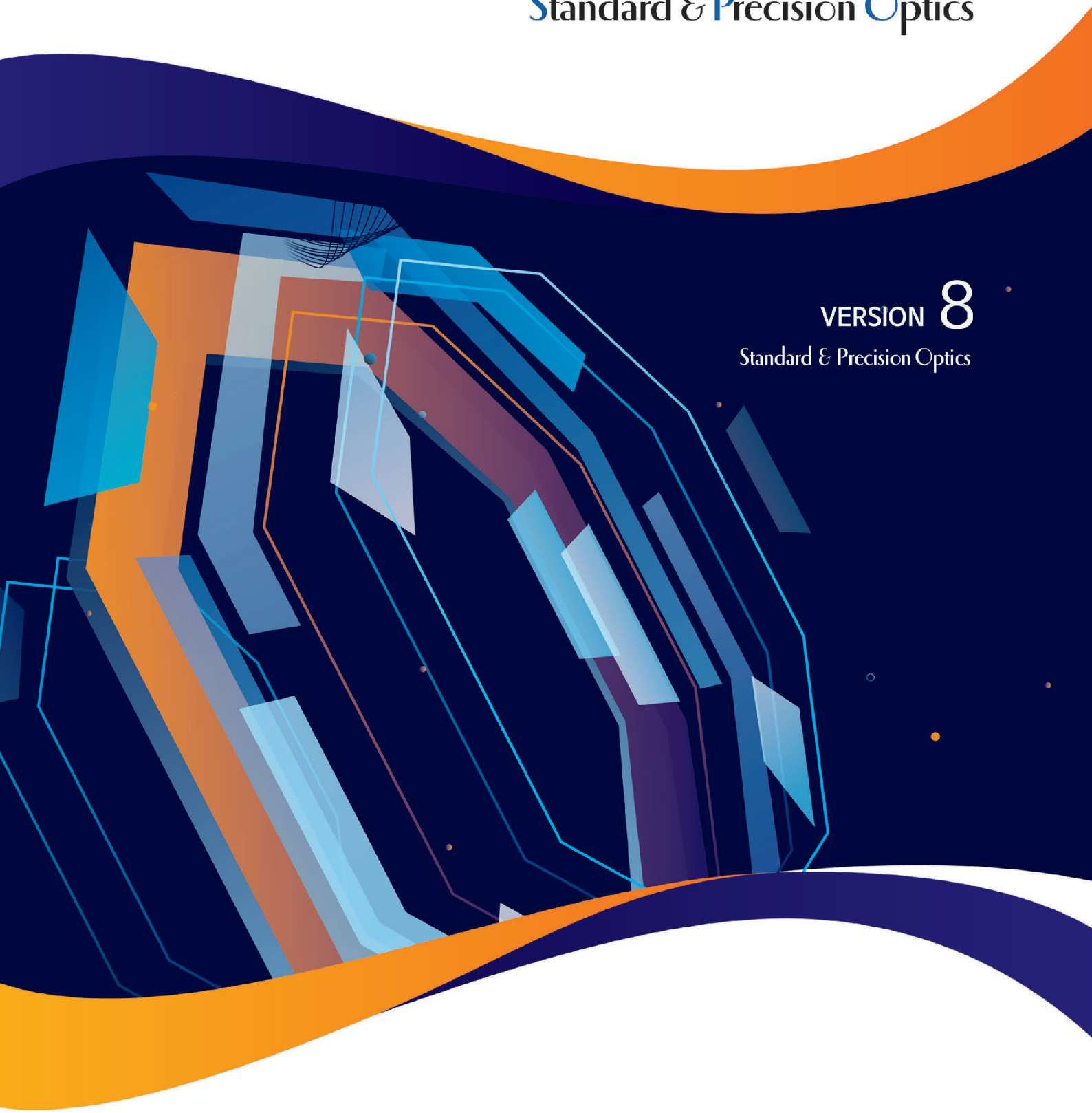
SPO Inc.™

Standard & Precision Optics



VERSION 8

Standard & Precision Optics

www.spoptics.com

Standard & Precision Optics

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Standard

Original Equipment Manufacturer

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INTRODUCTION

SPO Inc. would like to sincerely thank you for your interest regarding of SPO's products.

SPO Inc. is the company of machine vision optics whose main business is manufacturing of vision system modules which have been applied for the various fields like FPD(TFT & LCD, OLED) and SMT & PCB, Semiconductor and Automotive.

Optics is very significant and essential components to the industry field like machine vision system & precise metrology application(2D & 3D measurement). Also, it has been demanded for a longtime to improve the system quality and changed to the various applications continuously.

SPO Inc. has many experiences of customized lens designing and manufacturing for various lenses and modules those are high resolution telecentric lenses and special optical modules according to customer's requirement.

SPO Inc. also will try to give the great satisfaction throughout the accumulated technology to the customer who wants to find the best & fast solution.
In addition to, SPO Inc. will accompany with our customers for the succeed business throughout providing the reasonable price, high quality, and fast delivery.

SPO Inc. tries to keep on developing and researching for the new product and inquiry constantly to become the No.1 of optical development company in the world. It is delight to us that you take an interest in our products. If you have any needs for our products or customized products, please don't hesitate to contact us anytime.

SPO Inc. is sincerely looking forward to your warm concerning and interesting all the time.

Thanks!

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SPO would like to guide you for the machine vision components and system to make a decision for the proper lens and illumination in the various applications.
This explanation for SPO lens will give the easy to understand and choose the best choice.

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Model Explanation

O M - W I V - S - L

Example : TCL 0.5X - 110/DI - 5M

Optical System
- TCL : Telecentric Lens
- NTL : Non-Telecentric Lens
- TIL : Telecentric Illumination

M (Magnification)
- 00.000X

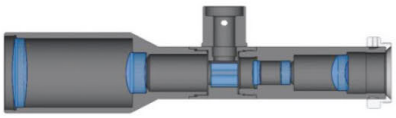
W.D (Working Distance)
- 000.0mm

Illumination Insert
- D : Coaxial Illumination
- : Non Coaxial Illumination

Variable Aperture
- I : Iris Type
- : Non Iris Type

Sensor Format
- 29M, 5M, HR, ST, 12K ···

Sensor Diagonal Length
- 32, 23, 11, 8 ···

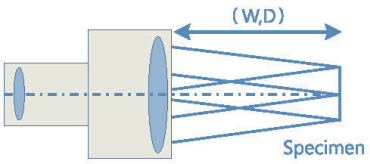


Lens Structure Schematic

Glossary

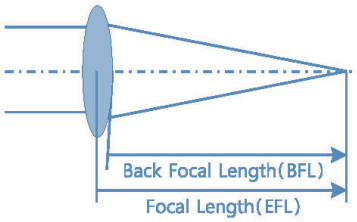
Working Distance (W,D)

Working distance is the distance from the front of optical lens to the surface of the specimen when in focus. If optical components like Illumination & Mirror Block are inserted between the lens and the specimen, Working Distance will be defined as from end of the component to specimen.



Focal Length & Back Focal Length (EFL & BFL)

Focal Length is the distance between the principal point and the focus plane.
Back Focal Length is the distance from the vertex of the last lens to the focus plane.

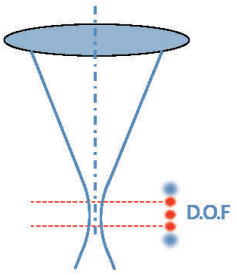


Depth of Field (Object Side) & Depth of Focus (Image Side) (D.O.F)

Depth of field is the range which is still remained sharp and focused even if object side is positioned between closer to and farther from best focus.

- Depth of Field = 2 x [(Permissible circle of confusion x effective F/#) / M^2]
- Permissible circle of confusion : Sensor Pixel Size x 4(Area Sensor),
  x 2(Line Sensor)

ex) Case of Area Sensor(@Pixel Size = 4.5㎛), F/#=8, Magnification = 1.3X
D.O.F = 2 x [(18㎛ x 8) / 1.3^2] = 170.4㎛

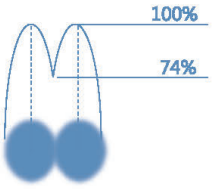


Depth of focus is the range which is still remained sharp and focused even if image side is positioned between closer to and farther from best focus.

Resolution

Resolving is the capacity to distinguish the minimum space between points and lines.
Resolving is determined by N.A and wavelength(λ).
Resolution = (0.61 x λ.) / N.A,

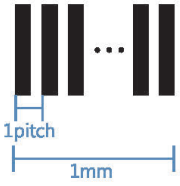
ex) 0.61 x 550㎚(λc) / 0.1 = 3.36㎛



Resolving Power

Resolving power is the number of lines per millimeter(lp/㎜) in which the black & white lines are distinguished. The resolving power is expressed by line/㎜.

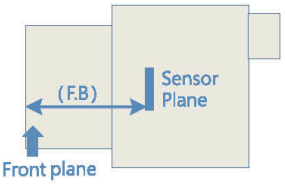
ex) 70lp/㎜ means to distinguish the line gap of the black & white of 1/70㎜ pitch.



Flange Back (F.B)

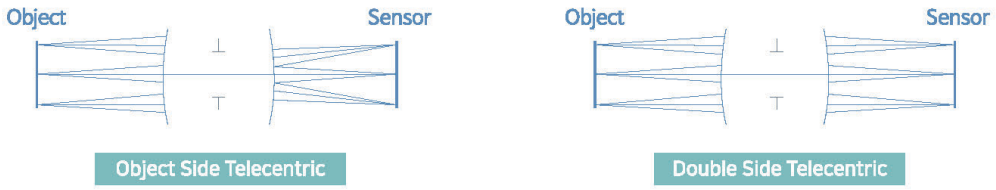
Flange back is the length between the sensor plane and the front plane of camera mount.

Mount	C-Mount	CS-Mount	F-Mount
F.B(㎜)	17.526	12.5	46.5



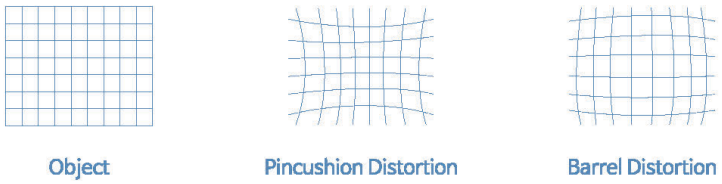
Telecentric System

- It is the optical system in which the principal ray is parallel to the optical axis of lens.
- There are three types of telecentric systems those are telecentric lens like Object side, Image side and Both sides.
- There is no perspective error and magnification change within D.O.F.



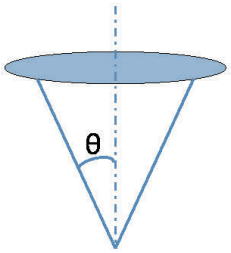
Distortion

- Distortion is one of the lens aberration that the straight line outside of the optical axis isn't displayed as straight line on the image plane.
- There are 2 types distortions those are positive and negative like pincushion distortion and barrel distortion.



Numerical Aperture

It is the measurement value of the cone of light accepted by a lens. The number is related to the lens's brightness and resolution. It is an important value that expresses the lens resolution.
The higher N.A have greater resolution and brightness of the lens.

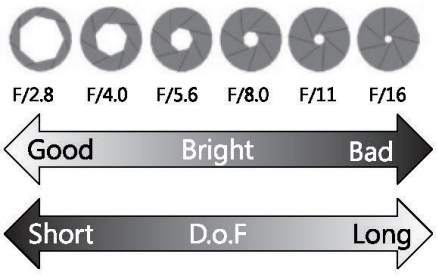


• Object N.A = n x sinθ (n : Object side refractive index)
• Image N.A′ = n′ x sinθ′ (n′ : Image side refractive index)

ex) N.A = 0.1 ▸ $\theta = \sin^{-1} 0.1 = 5.73°$

F-Number (Infinite) / Effective F-Number (Finite)

The F-Number value indicates of lens brightness.
The brightness is inversely proportional to a square number of F/#
Lower F/# has more brighter lens, but D.O.F will be short.



• **Infinite F-Number (object infinite distance)**

$$\text{F-Number} = \frac{\text{EFL}}{\Phi e\,(\text{entrance pupil diameter})}$$

= 1/2 N.A′ (Sensor Side N.A)

• **Effective F-Number (object finite distance)**

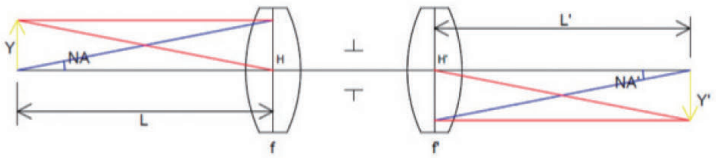
Effective F-Number = (1 + M) x Infinite F-Number
= 1/2 N.A′ (Sensor Side N.A)

The number indicates the lens's brightness value when the object is located in the finite position.

Optical Magnification

Magnification is a ratio between object and image size

$$\text{Magnification} = \frac{\text{Img Distance}(L')}{\text{Obj Distance}(L)} = \frac{\text{N.A}}{\text{N.A}'} = \frac{\text{Sensor Size}(Y')}{\text{Object Size}(Y)} = \frac{f'}{f}$$



Electronic Magnification

Electronic Magnification is a magnification of an image on camera sensor when displayed on a Monitor.

Field of View (F.O.V)

The viewable area of a captured object via lens and camera.
The F.O.V is Sensor Format size / optical magnification.

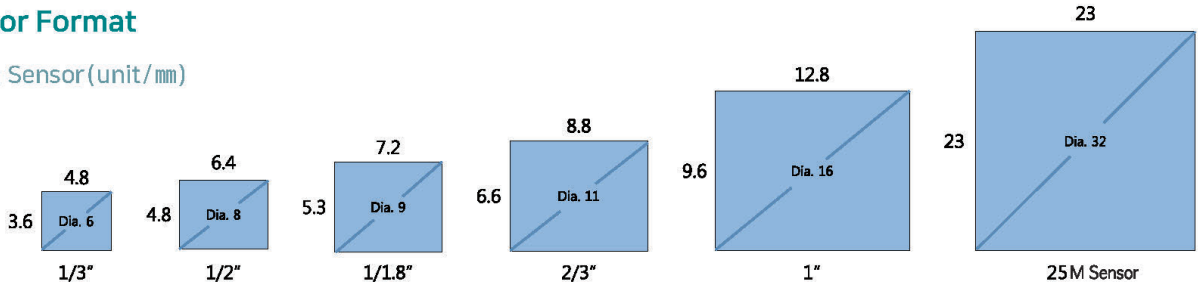
Monitor Magnification

Monitor magnification is the magnification of an object which is displayed on a monitor screen through a lens.
Monitor magnification = optical magnification x electronic magnification

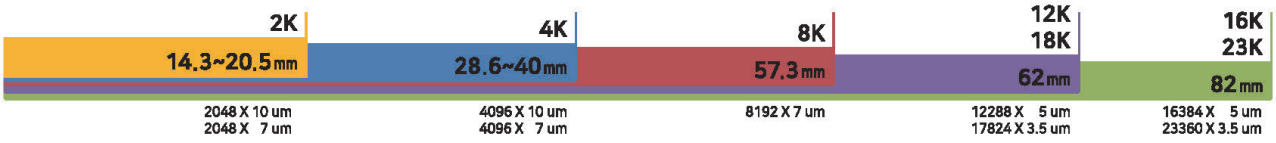
ex) optical magnification 0.2X, CCD Size ½"(Dia. 8㎜), Monitor 14"
Electronic magnification = (14 x 25.4) / 8 = 44.45X, (1" = 25.4㎜)
Monitor magnification = 0.2 x 44.45 = 8.89X

Sensor Format

- Area Sensor(unit/㎜)



- Line Sensor



Optical Unit & Illumination Method

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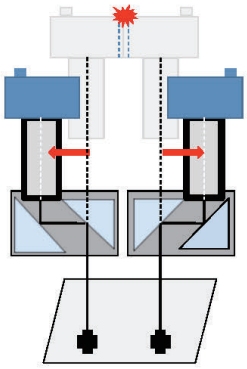
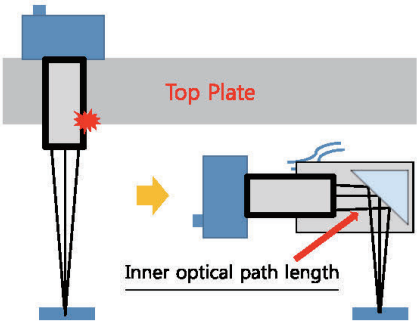
Optical Unit





Pitch Unit for Fiducial Mark Alignment

This unit is good for the inspection of the two fiducial mark at the same time. This system can be applied to at the narrow space efficiently and would prevent interference with each camera.

90 right Mirror Block for Narrow Space

This mirror block is useful when there is limited space on the equipment. Final image becomes mirror images and origin lens's W.D will be reduced due to inner optical path length.

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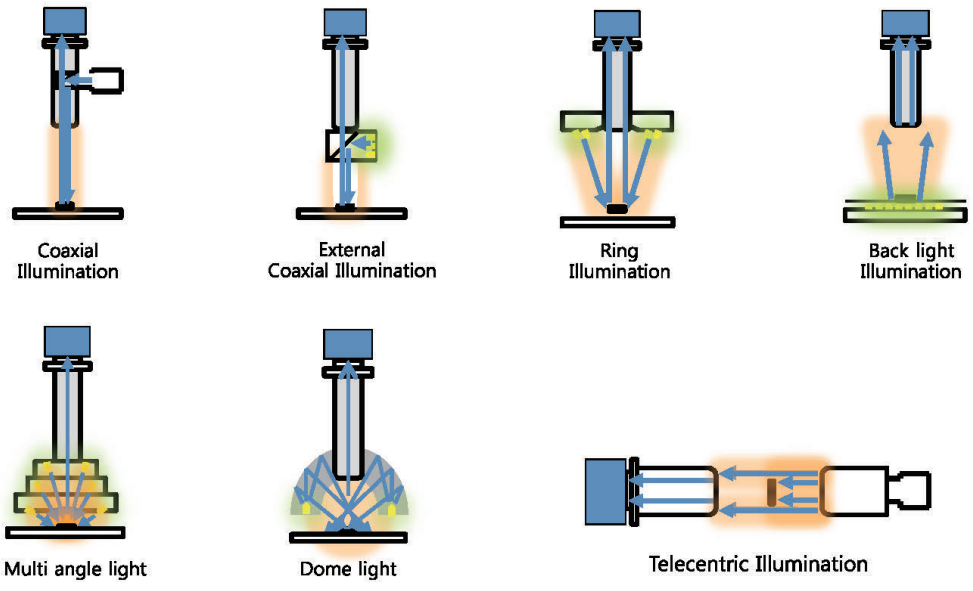
Application for illumination usage

Illumination choice is very significant in the machine vision system. Thus, it is essential to choose the proper illuminations according to applications. Choice of the improper illumination will lead to a variety of image problems like hot spot, blurring, shadowing & non-uniformity. Customer can choose a variety of illuminations according to applications like below.



SPO will provide the best solution for various applications through customized illuminations.

TCLOBJ Series

FEATURES

- SPO TCLOBJ Series lens is possible to measure FOV 1.3 times larger than other standard objective lens
- Designed to support up to 25M sensor which is 32㎜ diagonal length.
- Customer wants to measure precise component and big specimen for one time. These lenses have more big F.O.V. while maintaining the same quality.

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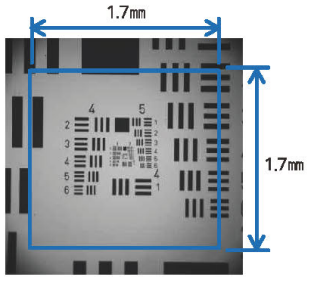
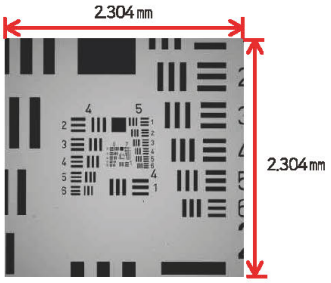
Standard 10X Vs. SPO 10X objective lens F.O.V & Image Quality Comparison



Standard 10X objective lens
(25M Sensor FOV)



TCL10.0X-30D-25M
(25M Sensor FOV)

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≃degree)	Optical Distortion (%)	Sensor size	Mount
TCL 5.0X-37D-25M	5.0X	37	2.24	0.15	16.67	24	0.04	0.03	25M(32㎜)	F
TCL 10.0X-30D-25M	10.0X	30	1.198	0.28	17.86	6.4	0.03	0.01	25M(32㎜)	F

* D.O.F Calculation : Permissible of circle of confusion : 18㎛

TCL 5.0X-37D-25

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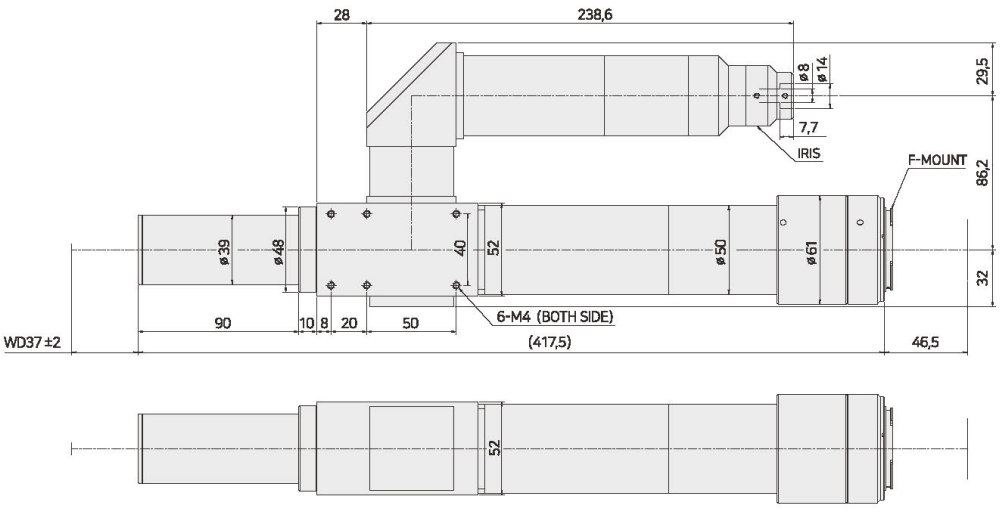

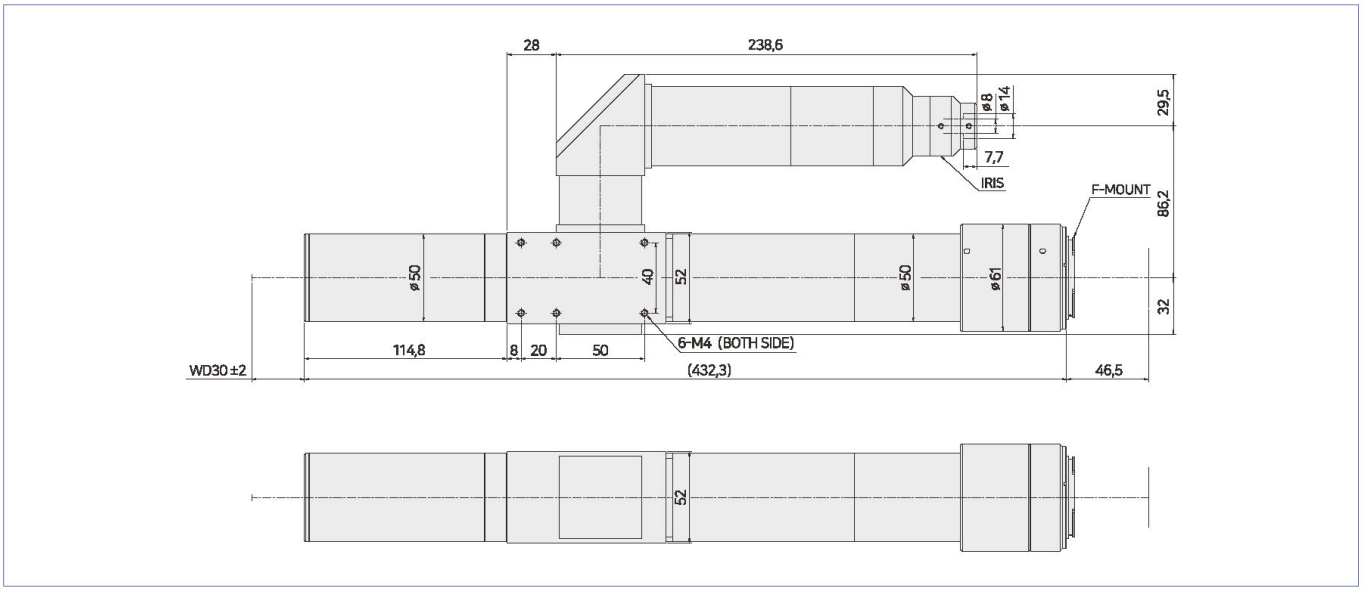

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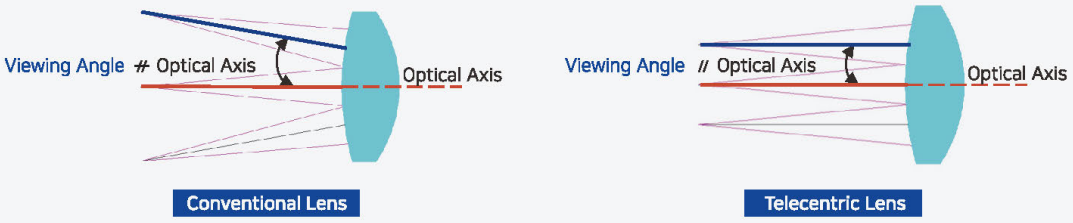
Conventional vs Telecentric Lens

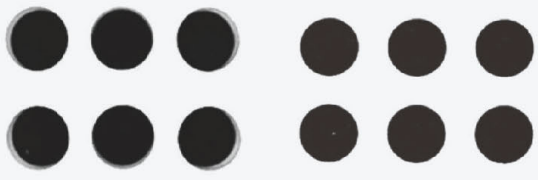
There is no viewing angle in case of telecentric lens which is difference with conventional lens. It means that viewing angle is parallel to optical axis of lens. Thus telecentric lens is good for the accurate and precise measurement applications. Below schematic shows the comparison of the conventional lens & telecentric lens.



Conventional Vs. Telecentric Lens Comparison

	Lens Size	Price	Magnification Variation	Viewing angle	Inner Coaxial Illumination
Conventional (NTL)	Small	Low - Priced	○	○	×
TCL	Large	High - Priced	×	×	○

Conventional & Telecentric Lens Image Comparison



[Conventional Lens Image]

[Telecentric Lens Image]

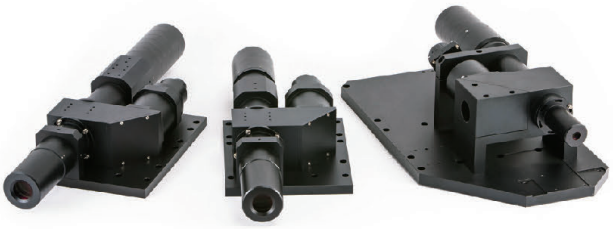
In case of conventional lens, it can't get same data for height object over the whole F.O.V due to perspective error.

There will be incorrect data closer to edge side due to viewing angle of lens. Besides, telecentric lens can get same data over the whole F.O.V.

TCL-Line Series

Telecentric lens for line scan camera (4K~16K)

- Lined up 4K to 16K line scan camera.
- Possible to use the inner coaxial illumination (12K & 3.5X / 5.0X / 7X / 10X) with uniform LED guide according to the illumination condition.
- Possible to adjust of the D.O.F by Iris diaphragm also change the mount according to any camera brand.



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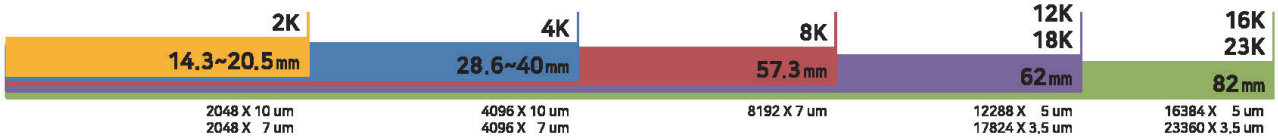
Sensor size for lens scan camera



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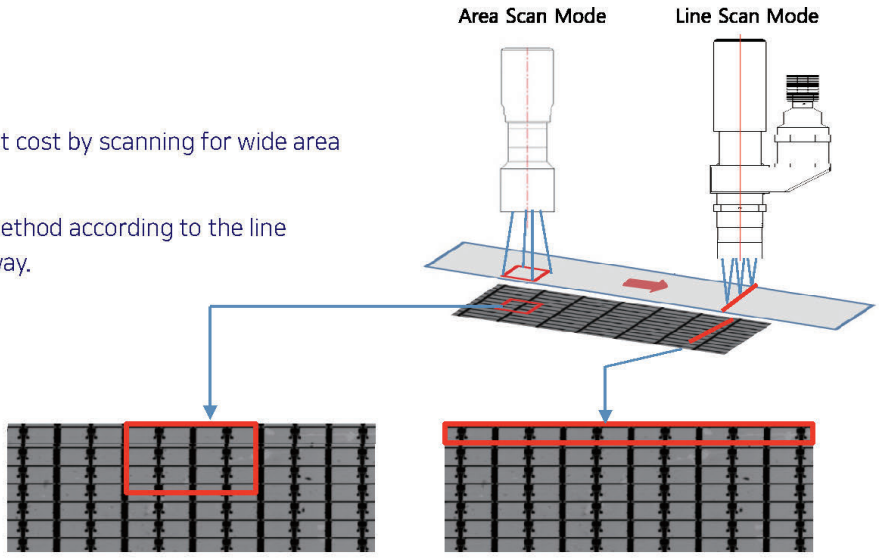
Area vs line scan

This series is good for the high level production process such like FPD(LCD, OLED), PCB(Printed Circuit Board), LED package inspection. It can save the tact time and equipment cost of the system. It is possible to be customized with various magnifications and W,D according to the customer's requirement while maintaining the same lens quality.
SPO has various lenses according to line sensor size and magnification and will provide the best solution for various applications.

Q. Why use the line scan camera?

A. It can save the tact time and equipment cost by scanning for wide area for one time.

B. It depends on the scanning time and method according to the line camera like sensor size and scanning way.



TCL-Line-16K Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≃degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.415X-170I-16K	0.415X	170	13	0.0259	8	929	0.04	0.06	16K(5㎛)	M90,M95
TCL 1.0X-148I-16K	1.0X	148	6.4	0.0526	9.5	190	0.04	0.03	16K(5㎛)	M90,M95
TCL 2.0X-130I-16K	2.0X	130	3.5	0.095	10.5	52.7	0.04	0.04	16K(5㎛)	M90,M95
TCL 10.0X-11D-16K-82	10.0X	11	1.1	0.3	16.67	3.34	0.04	0.03	16K(5㎛)	M90,M95

* D.O.F Calculation : Permissible of circle of confusion : 10㎛

TCL 0.415X-170I-16K

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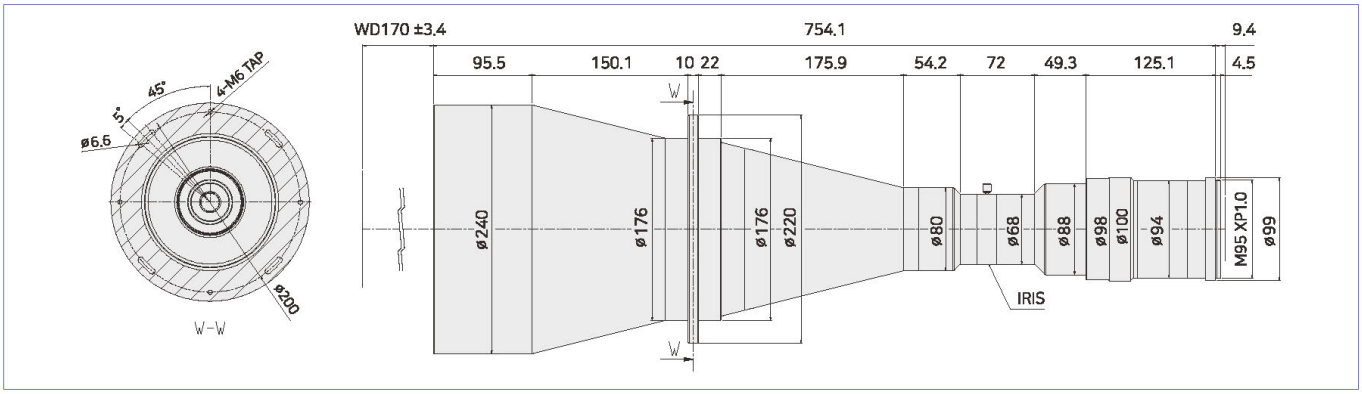

TCL 1.0X-148I-16K

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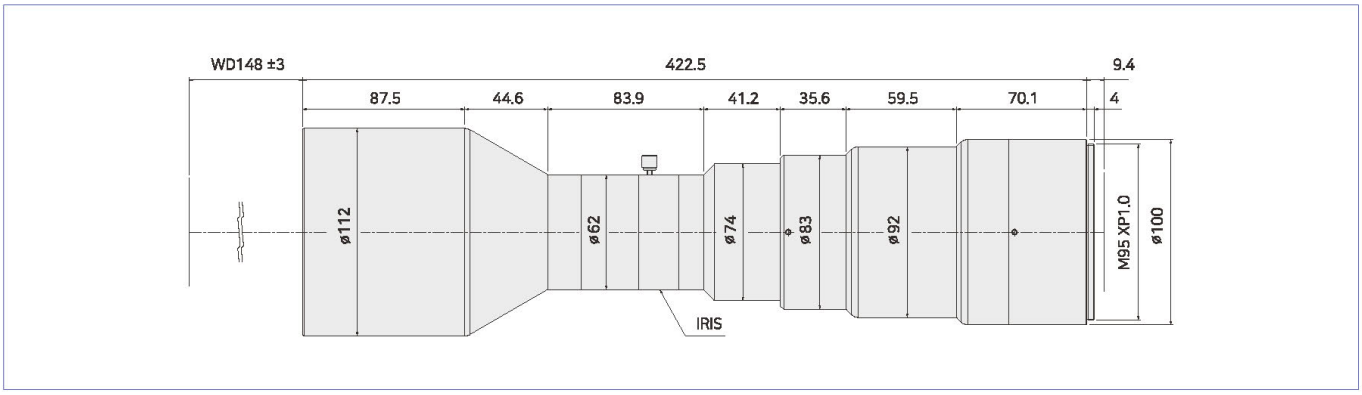

TCL 2.0X-130I-16K

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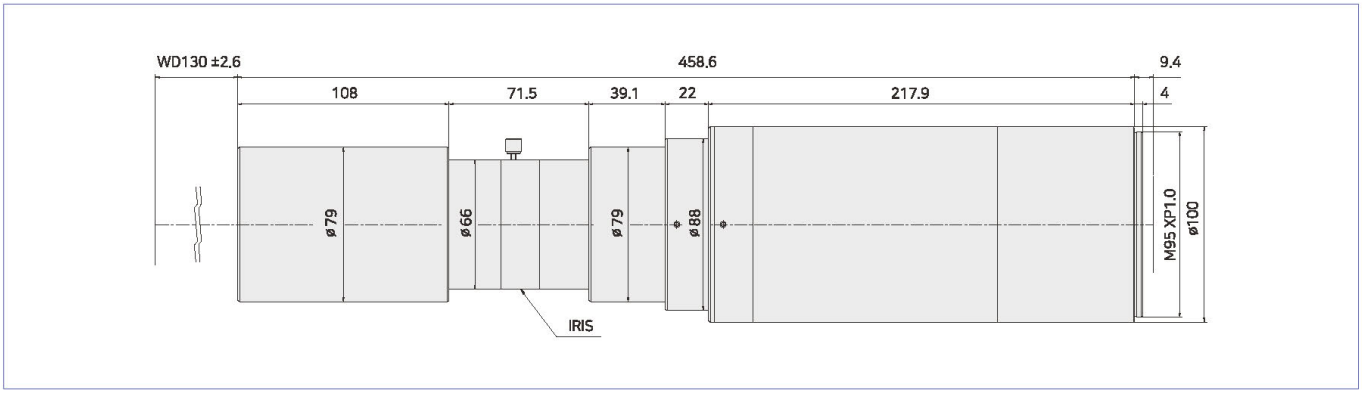
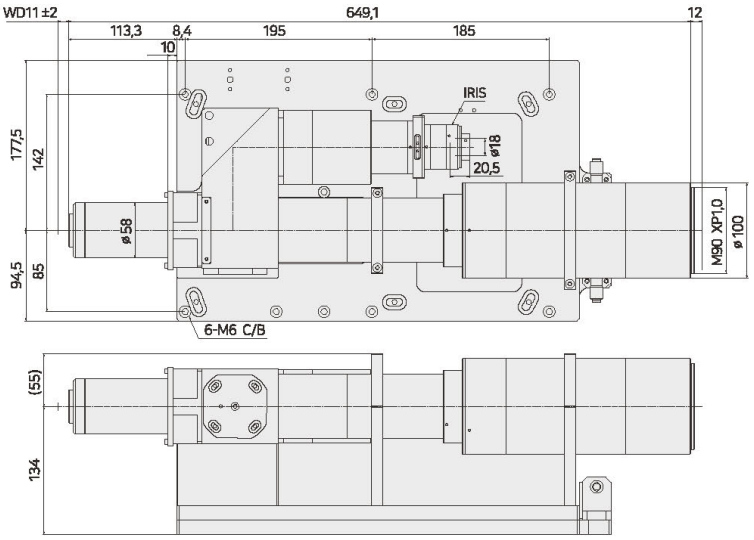


TCL10.0X-11D-16K-82



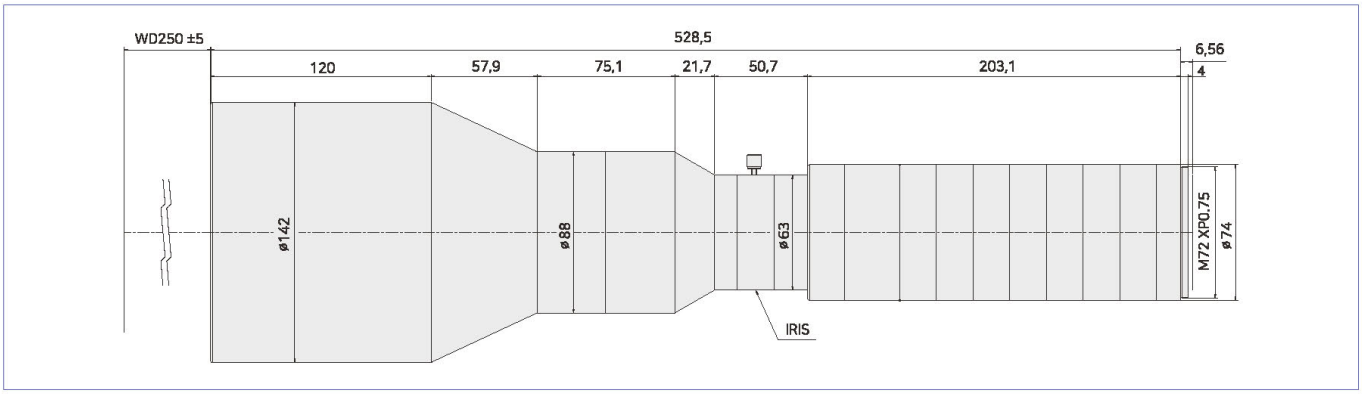
TCL-Line-12K Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≤degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.58X-250I-12K	0.58X	250	9.3	0.036	8	475	0.05	0.03	12K(5u)	M72
TCL 0.64X-170I-12K	0.64X	170	8.4	0.04	8	390	0.04	0.06	12K(5u)	M72
TCL 0.7X-117I-12K	0.7X	117	7.7	0.0437	8	326	0.04	0.07	12K(5u)	M72
TCL 0.7X-145/D-12K	0.7X	145	10.2	0.033	10.6	432	0.04	0.03	12K(5u)	M72
TCL 0.87X-137I-12K	0.87X	137	6.4	0.052	8.3	219	0.04	0.07	12K(5u)	M72
TCL 1.0X-122D-12K	1.0X	122	6.7	0.05	10	200	0.04	0.02	12K(5u)	M72
TCL 1.3X-105/D-12K	1.3X	105	5.6	0.06	10.8	128	0.03	0.03	12K(5u)	M72
TCL 2.0X-115I-12K	2.0X	115	3.9	0.085	11.8	59	0.04	0.03	12K(5u)	M72
TCL 3.5X-78/D-12K	3.5X	78	3.05	0.11	15.9	26	0.04	0.05	12K(5u)	M72
TCL 5.0X-78/D-12K	5.0X	78	2.6	0.13	19.2	15	0.04	0.08	12K(5u)	M72
TCL 7.0X-14.9/D-12K	7.0X	14.9	1.6	0.21	16.6	6.7	0.04	0.03	12K(5u)	M72
TCL 10.0X-13.5/D-12K	10.0X	13.5	1.7	0.2	25	5	0.04	0.02	12K(5u)	M72

* D.O.F Calculation : Permissible of circle of confusion : 10㎛

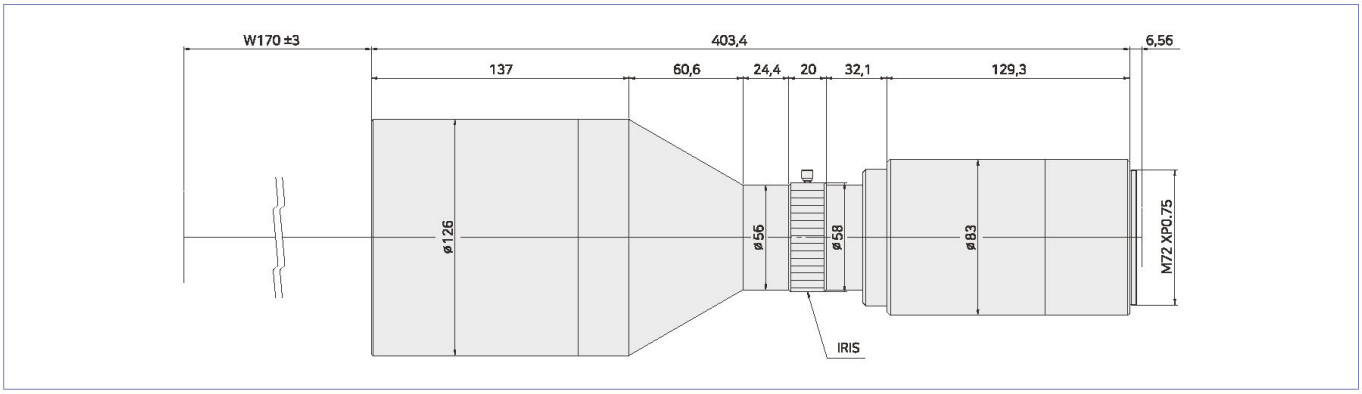
TCL 0.58X-250I-12K

Standard & Precision Optics



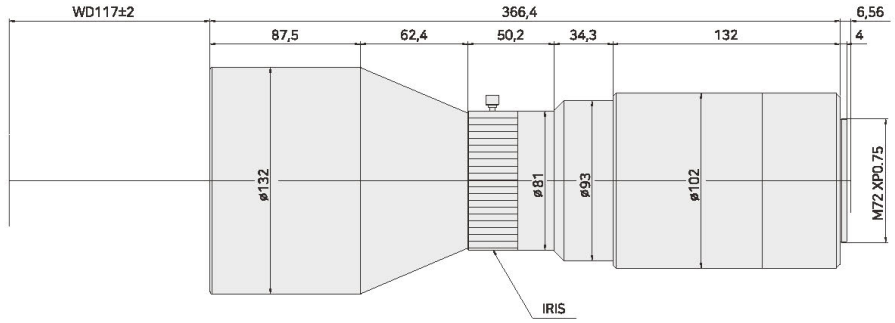
TCL 0.64X-170I-12K

Standard & Precision Optics



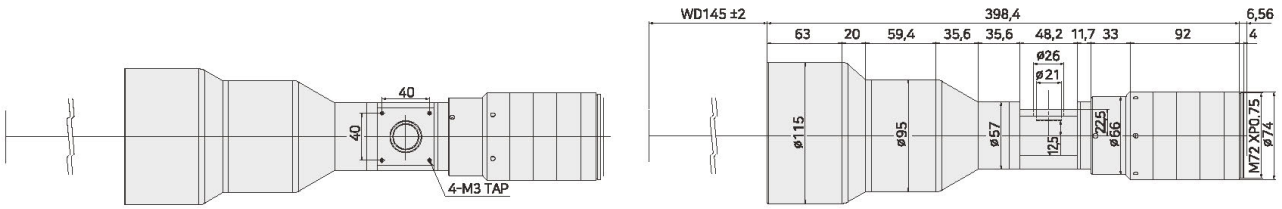
TCL 0.7X-117I-12K

Standard & Precision Optics



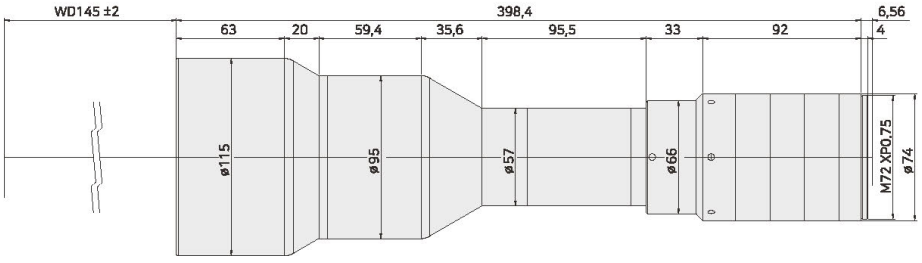
TCL 0.7X-145D-12K

Standard & Precision Optics



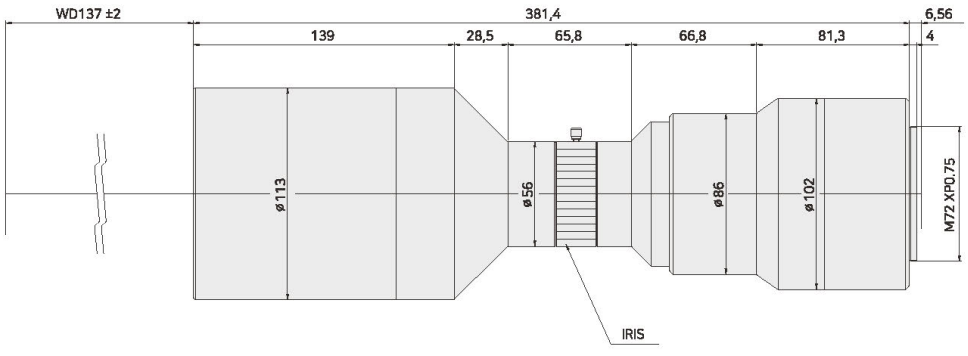
TCL 0.7X-145-12K

Standard & Precision Optics

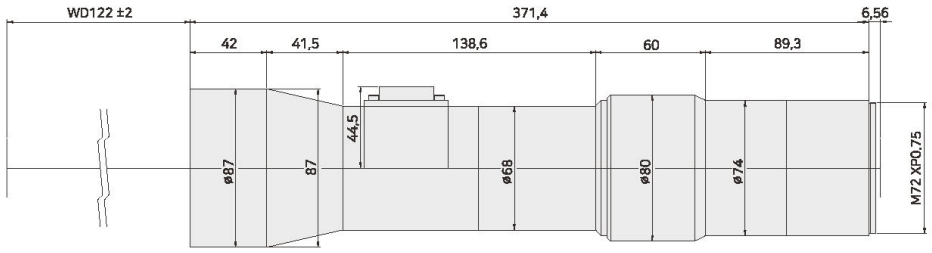


TCL 0.87X-137I-12K

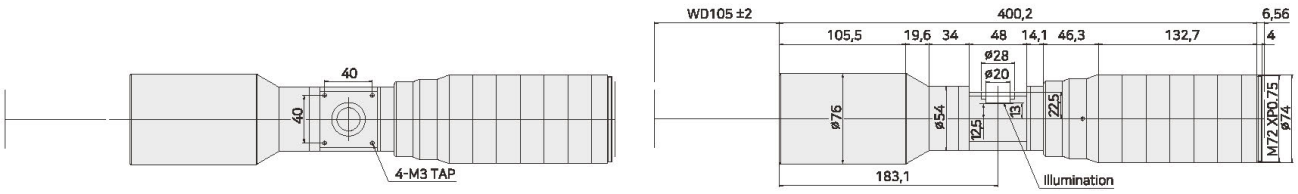
Standard & Precision Optics



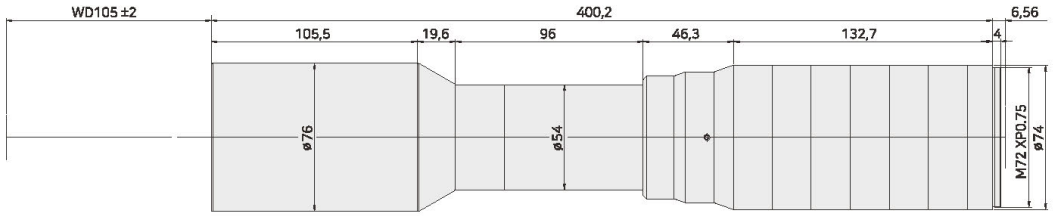
TCL 1.0X-122D-12K



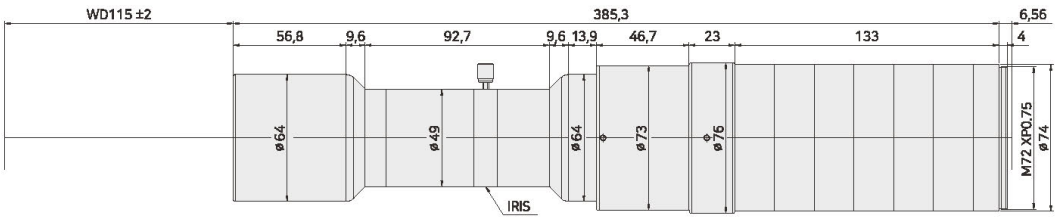
TCL 1.3X-105D-12K



TCL 1.3X-105-12K

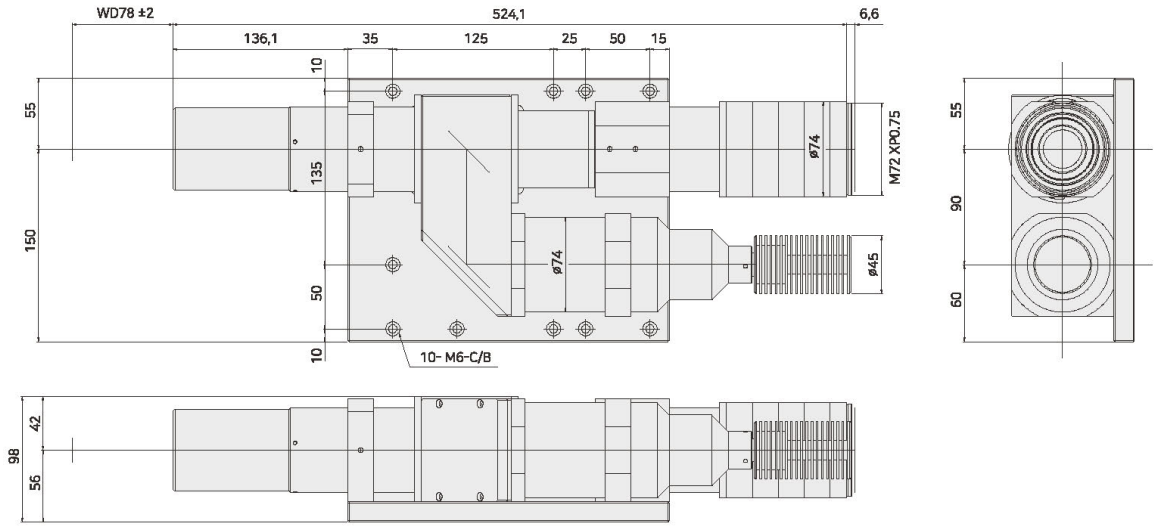


TCL 2.0X-115I-12K



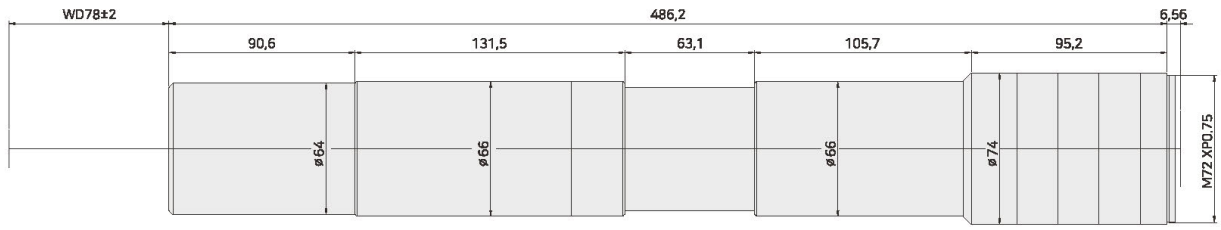
TCL 3.5X-78D-12K

Standard & Precision Optics



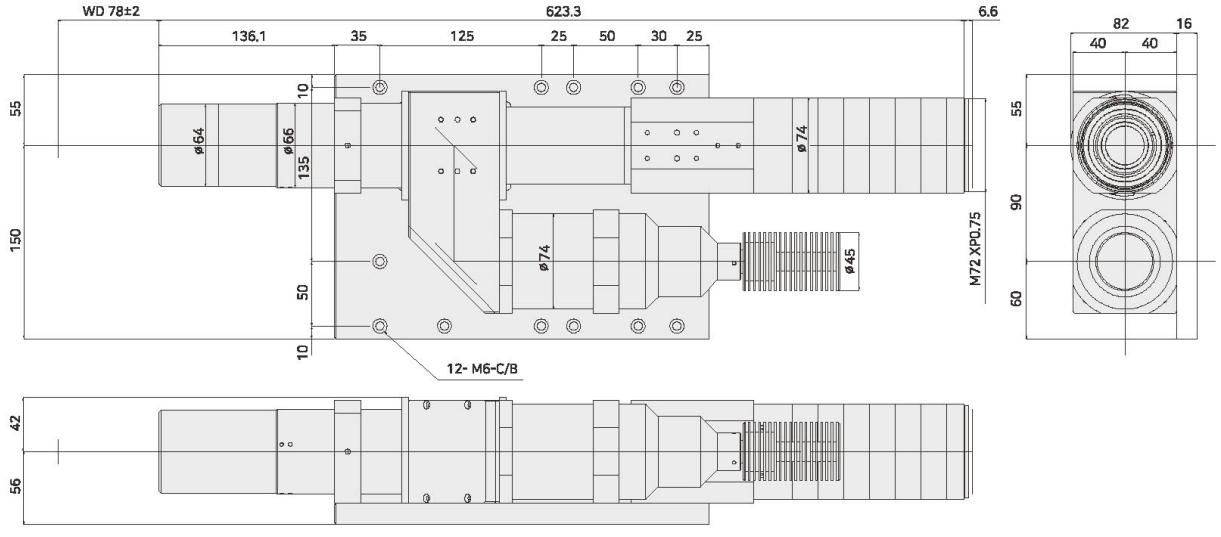
TCL 3.5X-78-12K

Standard & Precision Optics

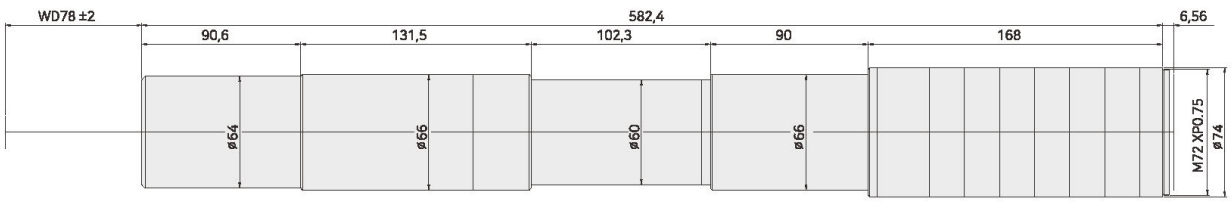


TCL 5.0X-78D-12K

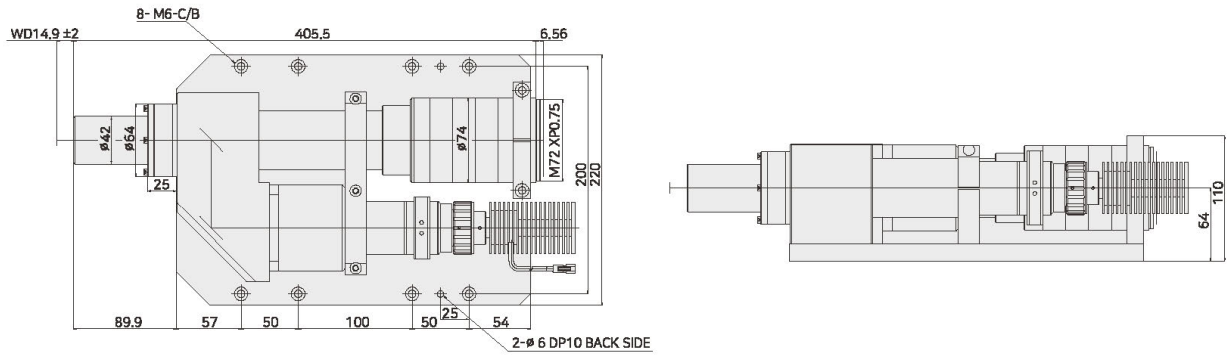
Standard & Precision Optics



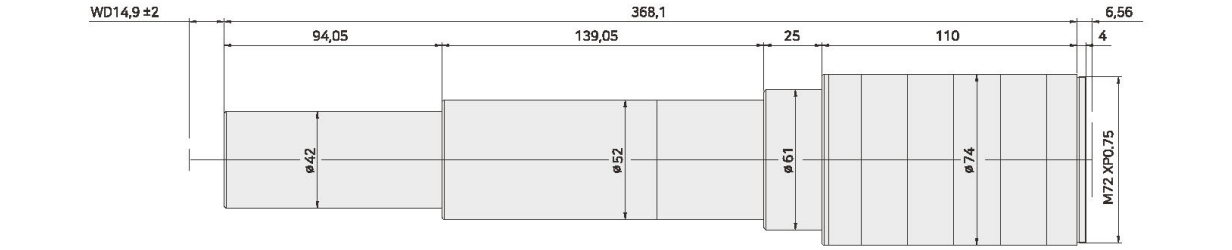
TCL 5.0X-78-12K



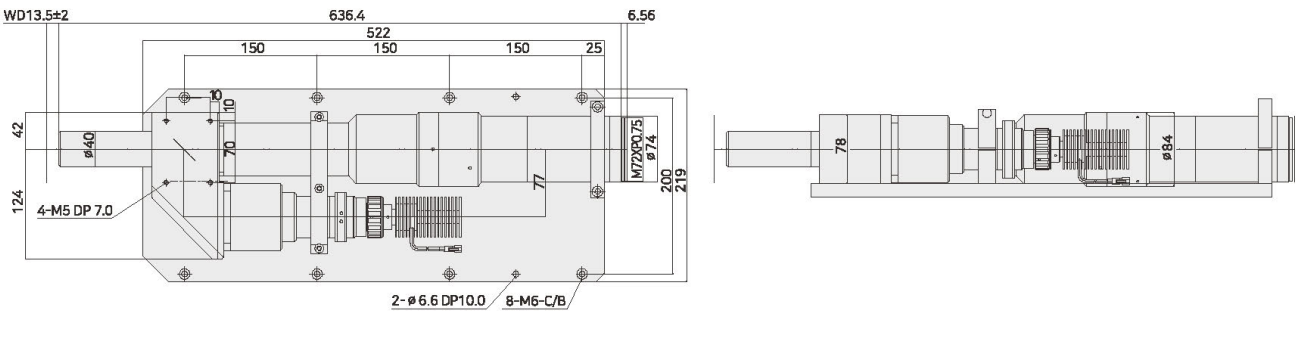
TCL 7.0X-14.9D-12K



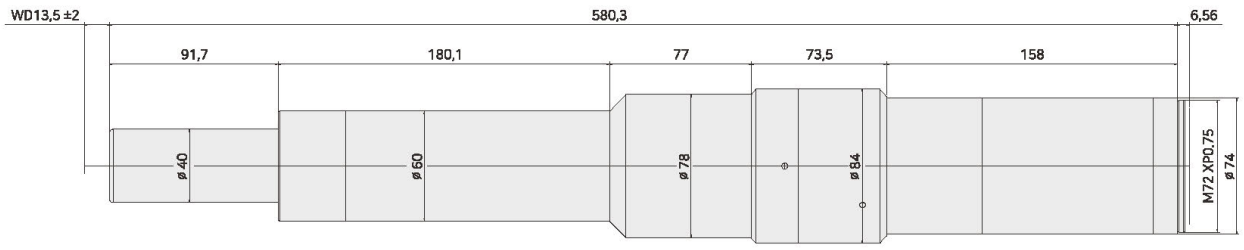
TCL 7.0X-14.9-12K



TCL 10.0X-13.5D-12K



TCL 10.0X-13.5-12K



Standard & Precision Optics

How to choose the proper lens ?

When choose the lens, has to be considered some factors to apply the application.
First, need to know the correct magnification according to F.O.V & camera sensor.
It can effect the performance of equipment. Below process shows the way for lens selection.

Standard & Precision Optics
Camera Select

- Sensor Resolution (pixel size) & Size (sensor diagonal length)
- ex) 5120 x 5120 @ 4.5㎛ (Diagonal 32.583㎜)
- Camera Mount Check (C, F, M48, M58, M72 mount, etc..)

Standard & Precision Optics
F.O.V Resolution

- Sample Size (F.O.V) & Demand resolution Check (optical resolution or pixel resolution)
- ex) 69.9㎜ x 69.9㎜

Standard & Precision Optics
Constraint Condition

- Object ~ Sensor Dimension (O.I) Check (W.D + Lens Length + Sensor Dimension)
- Illumination Type Select (Coaxial, External Coaxial, Ring, Bar, Line, Backlight etc..)

Standard & Precision Optics
Lens Select

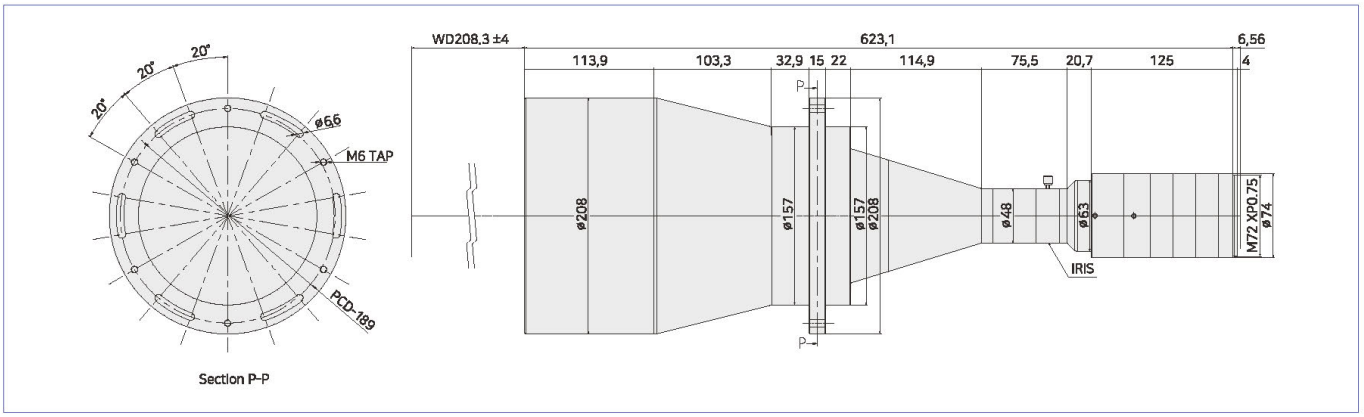
- Telecentric Lens or Macro Lens Series
- F/# / Resolution / N.A Check
- ex) TCL 0.33X-347I-25M (FOV 69.9 x 69.9㎜)

TCL-Line-8K Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≤degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.4X-208.3I-8K	0.4X	208.3	14	0.024	8.3	1452	0.04	0.04	8K(7㎛)	M72
TCL 0.467X-278/D-8K	0.467X	278	12	0.028	8.3	1066	0.04	0.03	8K(7㎛)	M72

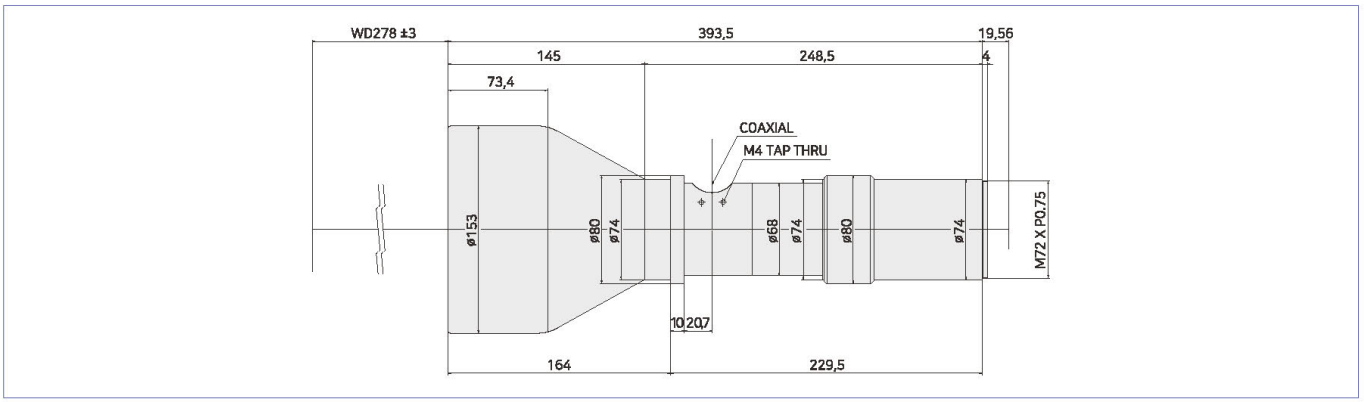
TCL 0.4X-208.3I-8K

Standard & Precision Optics



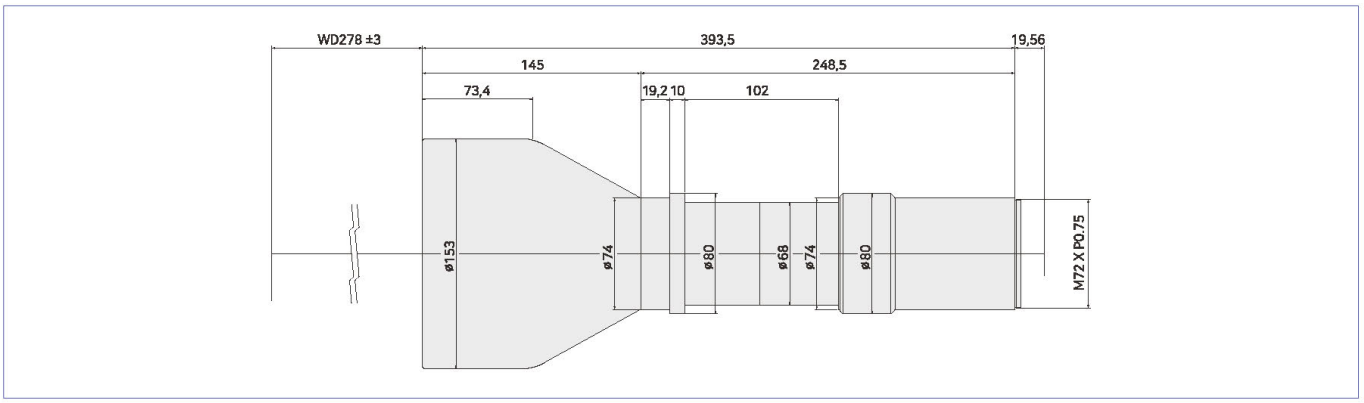
TCL 0.467X-278D-8K

Standard & Precision Optics



TCL 0.467X-278-8K

Standard & Precision Optics



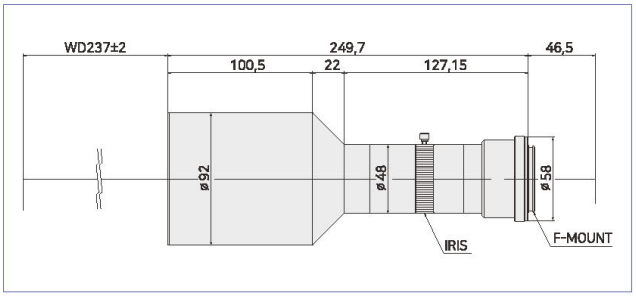
TCL-Line-4K Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (~< degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.5X-237I-4K	0.5X	237	8.4	0.04	6.25	700	0.03	0.08	4K(7㎛)	F
TCL 0.7X-130I-4K	0.7X	130	5.1	0.066	5.3	303	0.04	0.05	4K(7㎛)	F
TCL 0.77X-140I-4K	0.77X	140	7	0.0477	8	540	0.03	0.06	4K(10㎛)	F
TCL 0.92X-170I-4K	0.92X	170	5.2	0.064	7.2	238	0.01	0.03	4K(7㎛)	F
TCL 1.0X-138I-4K	1.0X	138	6.1	0.055	9.1	364	0.04	0.02	4K(10㎛)	F
TCL 2.0X-102-4K	2.0X	102	3.7	0.09	11.1	111	0.03	0.07	4K(10㎛)	F

* Remark : Possible to change of mount

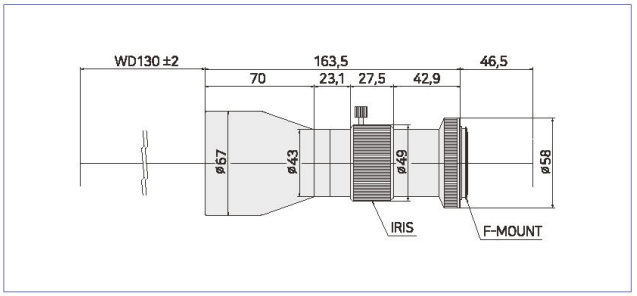
TCL 0.5X-237I-4K

Standard & Precision Optics



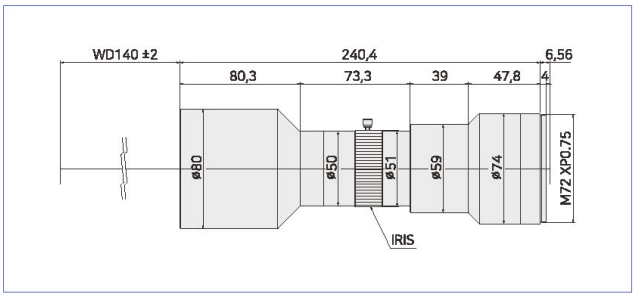
TCL 0.7X-130I-4K

Standard & Precision Optics



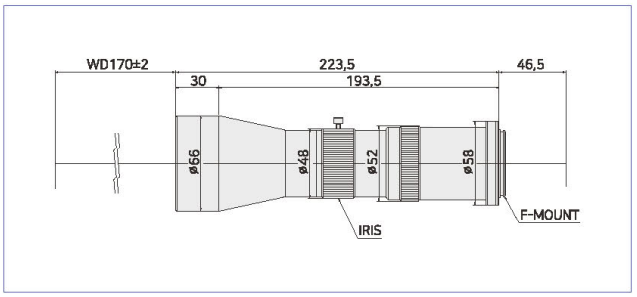
TCL 0.77X-140I-4K

Standard & Precision Optics



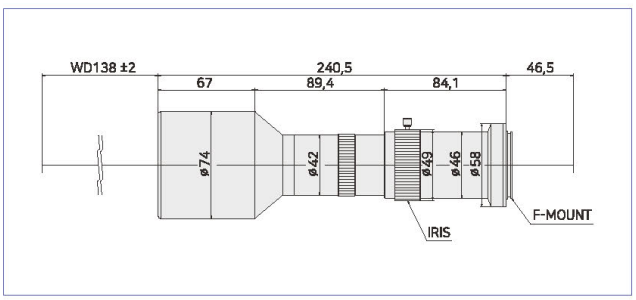
TCL 0.92X-170I-4K

Standard & Precision Optics



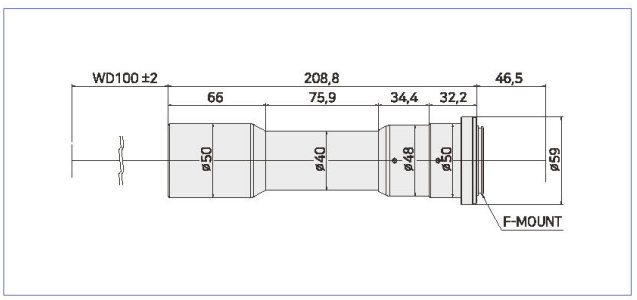
TCL 1.0X-138I-4K

Standard & Precision Optics



TCL 2.0X-102-4K

Standard & Precision Optics



Standard & Precision Optics

TCL-47M Series

FEATURES

- This lens can be applied for 47M sensor camera which has 56.7㎜ diagonal length.
- It is good for various inspections those are FPD (Flat Panel Display) like LCD, OLED applications & automotive and mobile components.
- High resolution and good telecentricity.
- Iris diaphragm adapted for adjusting D.O.F.

Currently, there is a demand for large F.O.V inspection of the machine vision applications. Especially, 47M lens has designed to support the huge sensor size to inspect a large object like LCD, OLED panel. Thus, it is the main reason why the customer wants to get the huge camera sensor for their application.

It is really suitable for the plat panel cell, module inspection and OLED & LED Pattern inspection for large panel. It is used for the not only sealant panel, but also panel quality inspection (On/Off inspection). In addition, it also can be applied to automotive (tube, seals and O-ring) and mobile components (Battery, case, PCB hole) for the large object. It is possible to be customized the lens according to the customer's demand specification.

TCL-47M Series

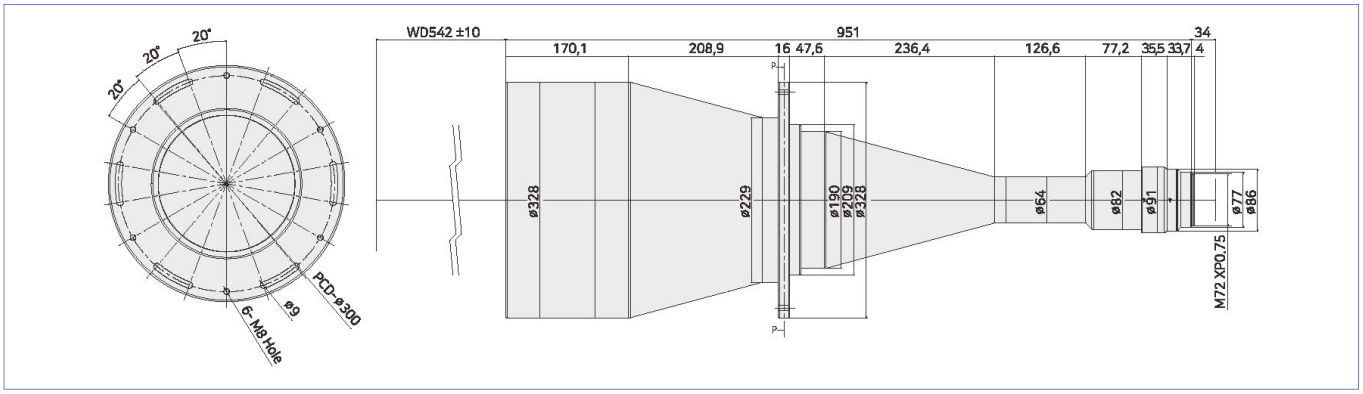
* Remark : It is compatible with 47M CAMERA

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≤degree)	Optical Distortion (%)	Sensor size	Mount
DTCL 0.2X-542-47M	0.2X	542	26	0.013	7.7	8.4㎜	0.03	0.04	47M(56.7㎜)	M72
TCL 0.4X-208.3I-47M	0.4X	208.3	14	0.024	8.3	2.3㎜	0.04	0.04	47M(56.7㎜)	M72
TCL 0.64X-170I-47M	0.64X	170	8.4	0.04	8	860	0.04	0.06	47M(56.7㎜)	M72
TCL 0.7X-117I-47M	0.7X	117	7.7	0.0437	8	718	0.04	0.07	47M(56.7㎜)	M72
TCL 0.87X-137I-47M	0.87X	137	6.4	0.052	8.3	482	0.04	0.07	47M(56.7㎜)	M72
TCL 1.0X-122/D-47M	1.0X	122	6.7	0.05	10	440	0.04	0.02	47M(56.7㎜)	M72
TCL 1.3X-105/D-47M	1.3X	105	5.6	0.06	10.8	281	0.03	0.03	47M(56.7㎜)	M72

* D.O.F Calculation : Permissible of circle of confusion : 22㎛ * DTCL : Double Side Telecentric Lens

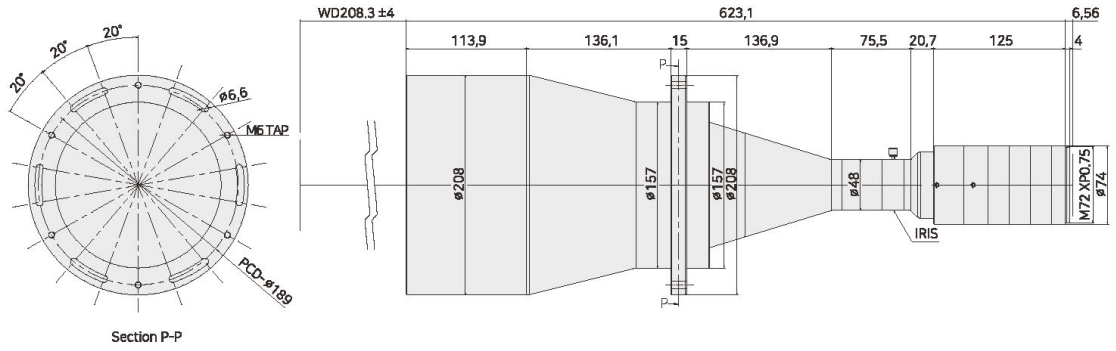
DTCL 0.2X-542-47M

Standard & Precision Optics



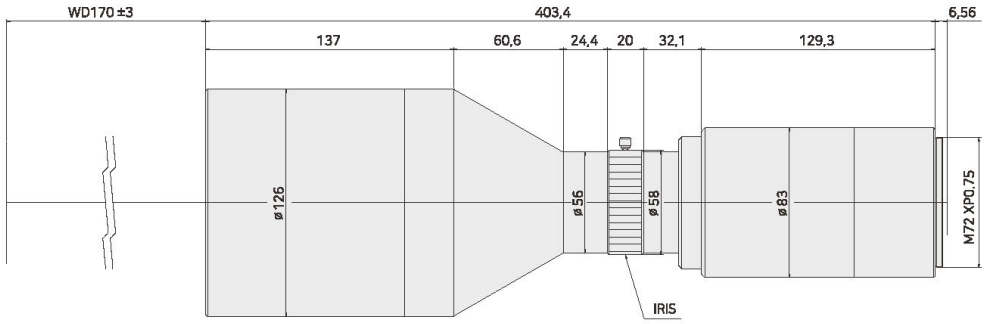
TCL 0.4X-208.3I-47M

Standard & Precision Optics



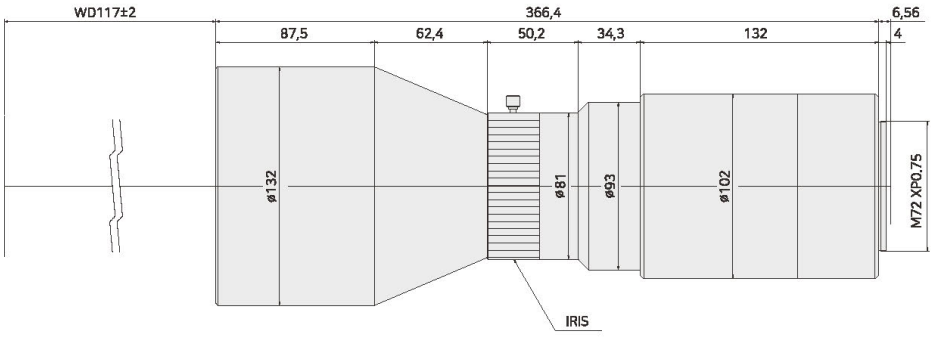
TCL 0.64X-170I-47M

Standard & Precision Optics



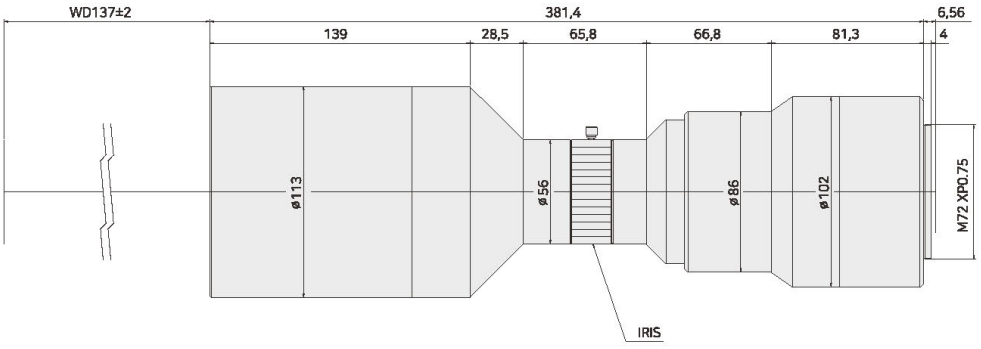
TCL 0.7X-117I-47M

Standard & Precision Optics

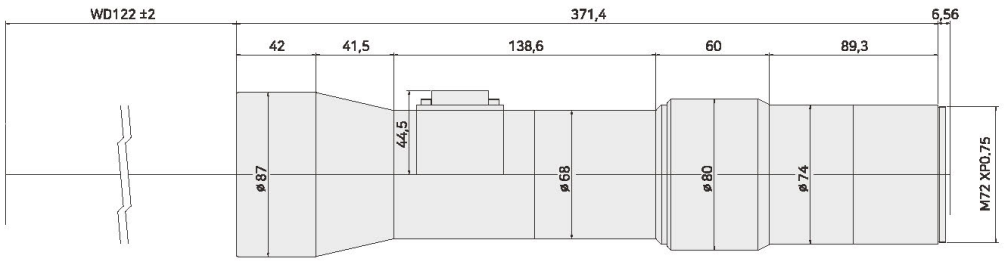


TCL 0.87X-137I-47M

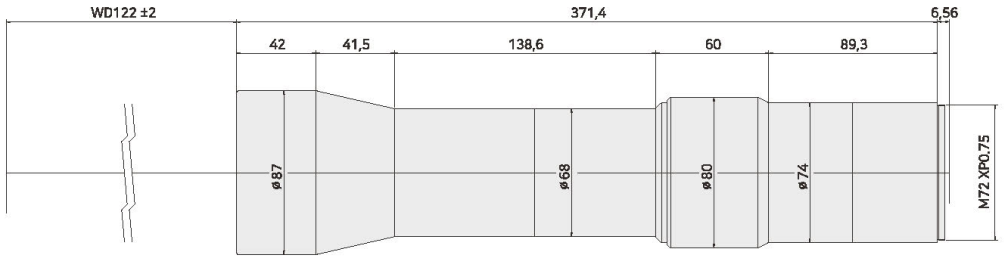
Standard & Precision Optics



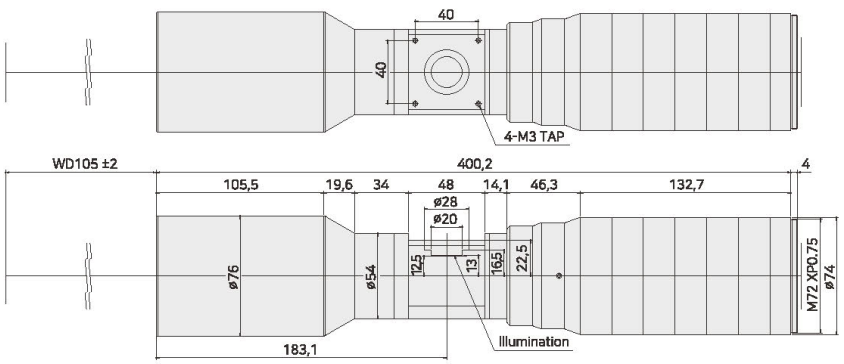
TCL 1.0X-122D-47M



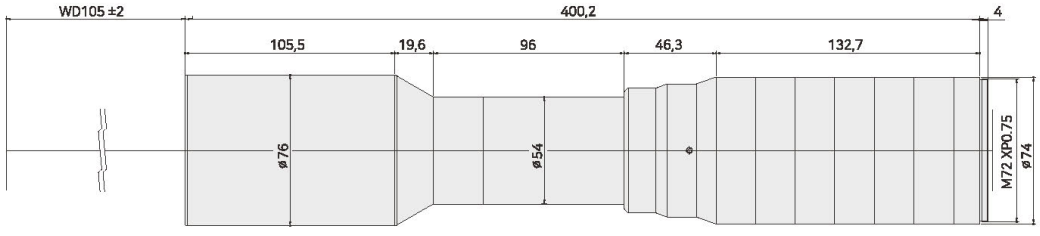
TCL 1.0X-122-47M



TCL 1.3X-105D-47M



TCL 1.3X-105-47M

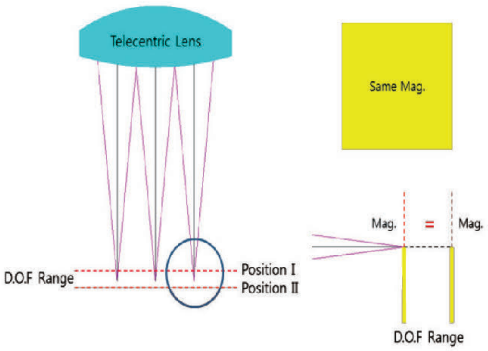


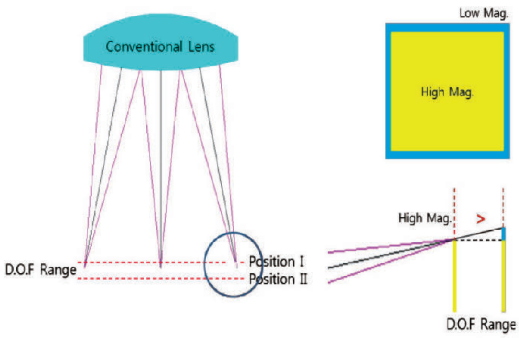
Double Side Telecentric Lens Series

FEATURES

- Can apply to Mega Pixel Camera like 5M, 4M, 16M, 29M and 4K, 8K (Diagonal length from 11㎜ to 43㎜).
- Possible to adapt M58-Mount in case of 29M series also change the mount according to camera brands who have own flange back length.
- High resolution and high telecentricity regarding of all series.
- Iris diaphragm adapted for adjusting D.O.F.

Telecentric means that the principal ray is parallel to the optical axis in the optical system.
The standard telecentric lens is generally is called object side telecentric lens.
Telecentric lens is good for the accurate measurement without perspective error over the whole F.O.V.
Also, there is no magnification change within the depth of field (D.O.F) even if W.D moves up and down.
On the other hand, general lens has magnification change by perspective error due to viewing angle when W.D moves up and down also to be seen the side barrier of in case of height object.
Finally, telecentric system is the best way to do an accurate measurement in the machine vision applications.





The double side telecnetirc lens means object and image side telecentric lens. There is no magnification change within D.O.F for both sides.
It will be good choice for the most precise measurement for the large specimen like automobile (tube, seals and O-rings, screw & bolts), molding and casting (drilling hole, edge shape), mobile components (battery, case, PCB hole) applications.

In addition, it is possible to do more accurate measurement by applying the telecentric illumination in case of shape, hole, and height inspection.

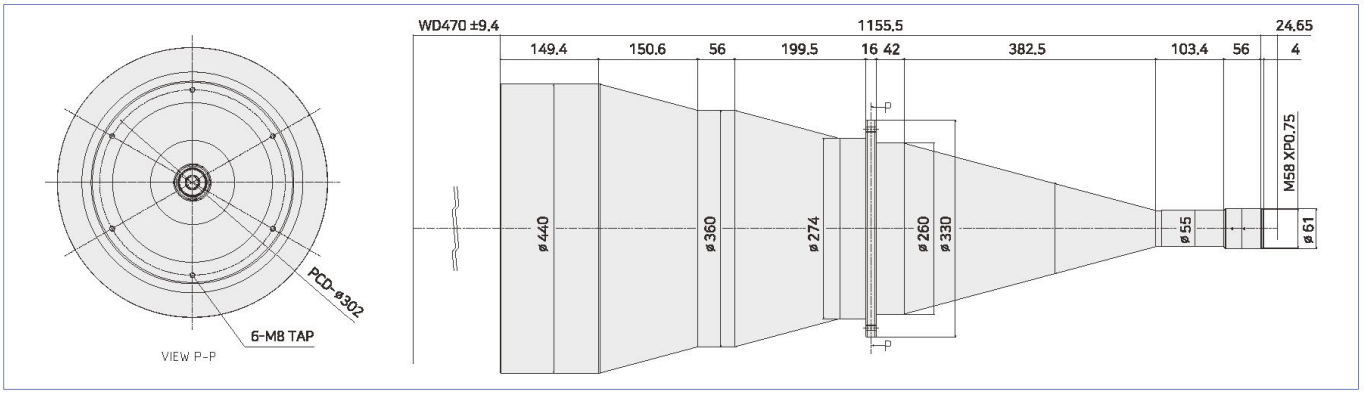
DTCL Series | 4M&25M&29M Camera

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Telecentricity (≃degree)	Optical Distortion (%)	Sensor size	Mount
DTCL 0.08X-470-25M	0.08X	470	59	0.0057	7	39.37	0.04	0.06	25M(32㎜)	M58
DTCL 0.1X-470I-4M	0.1X	470	52	0.0065	7.7	33.9	0.05	0.026	4M(22㎜)	F
DTCL 0.15X-545-29M	0.15X	545	34	0.0097	7.7	15.05	0.05	0.03	29M(43㎜)	M58
DTCL 0.24X-405I-29M	0.24X	405	28	0.012	10	7.6	0.05	0.03	29M(43㎜)	M58
DTCL 0.38X-265I-29M	0.38X	265	17.6	0.019	10	3.05	0.04	0.03	29M(43㎜)	M58
DTCL 0.563X-160I-29M	0.563X	160	12	0.028	10	1.4	0.05	0.04	29M(43㎜)	M58
DTCL 0.664X-181I-29M	0.664X	181	8.4	0.04	8.3	828㎛	0.05	0.05	29M(43㎜)	M58

* D.O.F Calculation : Permissible of circle of confusion : 22㎛ * DTCL : Double Side Telecentric Lens

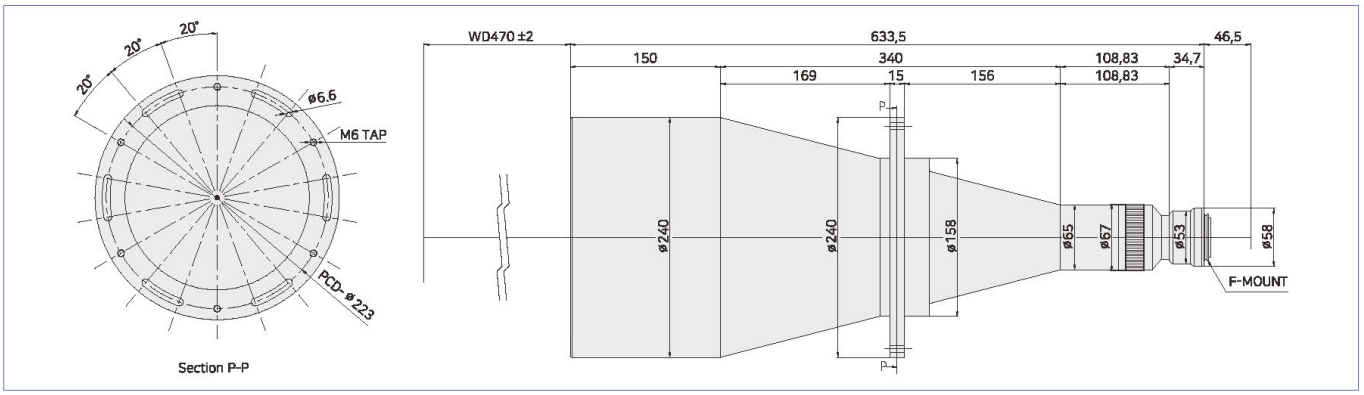
DTCL 0.08X-470-25M

Standard & Precision Optics



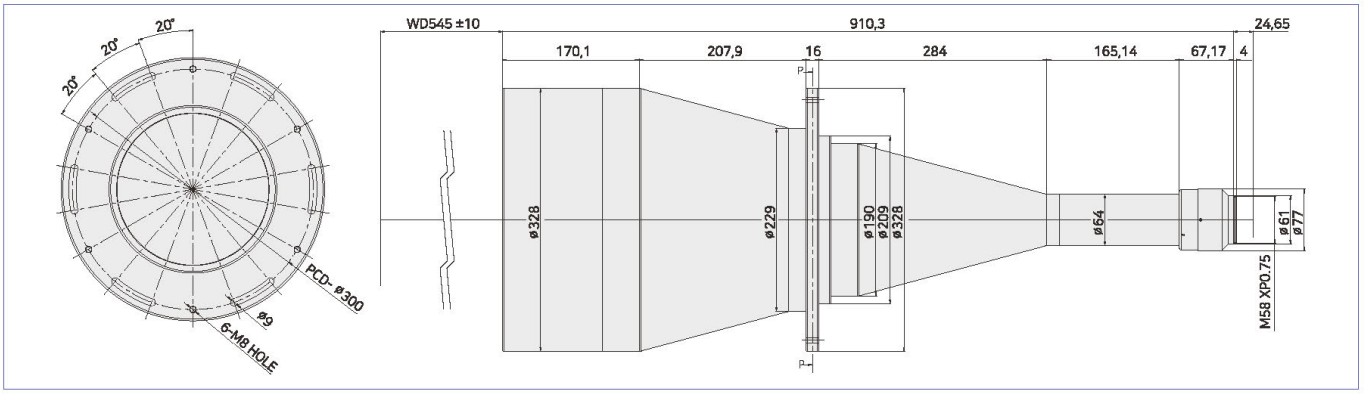
DTCL 0.1X-470I-4M

Standard & Precision Optics



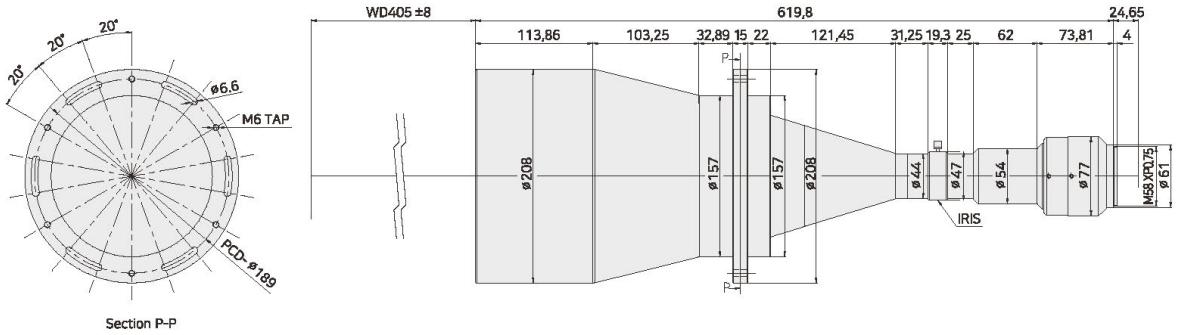
DTCL 0.15X-545-29M

Standard & Precision Optics



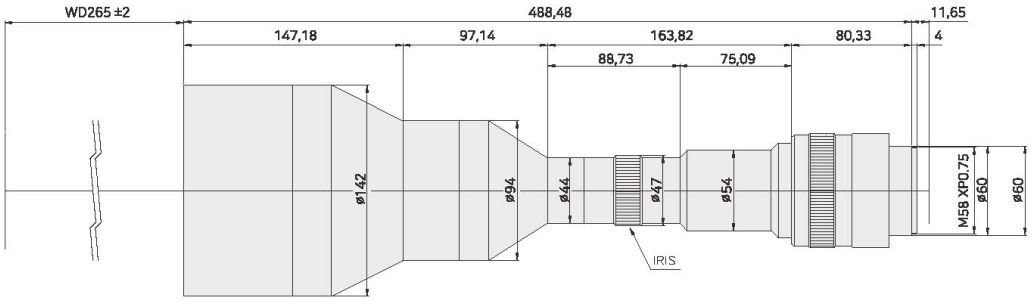
DTCL 0.24X-405I-29M

Standard & Precision Optics



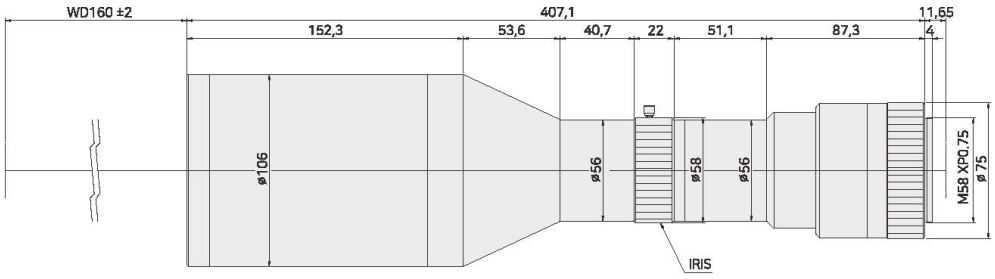
DTCL 0.38X-265I-29M

Standard & Precision Optics



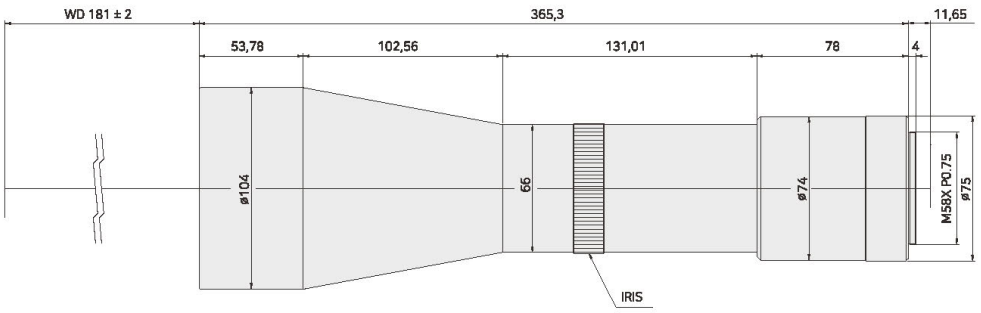
DTCL 0.563X-160I-29M

Standard & Precision Optics



DTCL 0.664X-181I-29M

Standard & Precision Optics



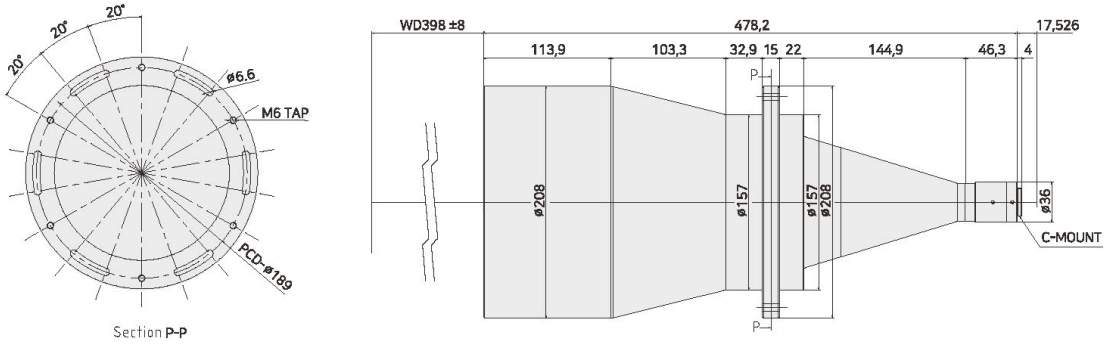
DTCL Series | Standard Camera

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Telecentricity (≤degree)	Optical Distortion (%)	Sensor size	Mount
DTCL 0.044X-398-8	0.044X	398	116	0.0029	7.5	154.9	0.05	0.03	1/2"(8㎜)	C
DTCL 0.061X-398-11	0.061X	398	78	0.0043	7	75.24	0.05	0.03	2/3"(11㎜)	C
DTCL 0.12X-230-11	0.12X	230	41	0.0082	7.3	20.27	0.04	0.03	2/3"(11㎜)	C
DTCL 0.138X-184-11	0.138X	184	36	0.0094	7.3	15.3	0.05	0.03	2/3"(11㎜)	C
DTCL 0.157X-160-11	0.157X	160	32	0.0104	7.5	12.1	0.05	0.03	2/3"(11㎜)	C
DTCL 0.184X-135-11	0.184X	135	27	0.0122	7.5	8.8	0.04	0.05	2/3"(11㎜)	C
DTCL 0.24X-108-11	0.24X	108	21	0.016	7.5	5.2	0.04	0.04	2/3"(11㎜)	C
DTCL 0.255X-70-9	0.255X	70	21	0.016	8	4.9	0.03	0.04	1/1.8"(9㎜)	C
DTCL 0.35X-72-11	0.35X	72	14	0.0233	7.5	2.4	0.05	0.04	2/3"(11㎜)	C
DTCL 0.5X-72/D-11	0.5X	72	11.2	0.03	8.33	1.3	0.04	0.03	2/3"(11㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛ * DTCL : Double Side Telecentric Lens

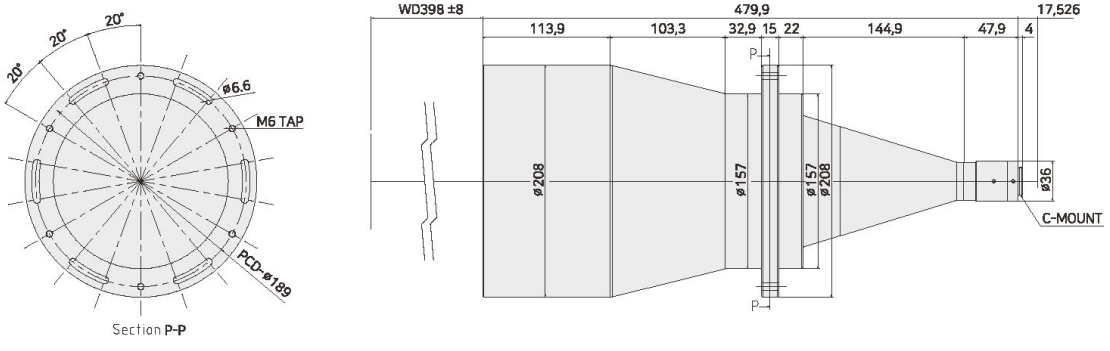
DTCL 0.044X-398-8

Standard & Precision Optics



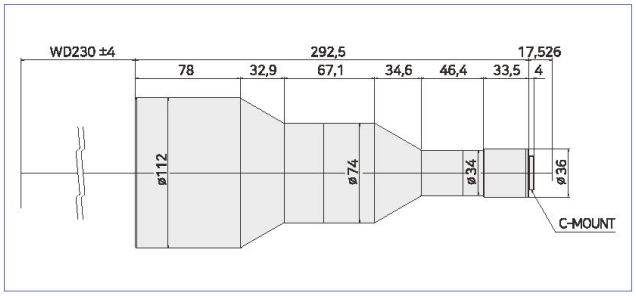
DTCL 0.061X-398-11

Standard & Precision Optics



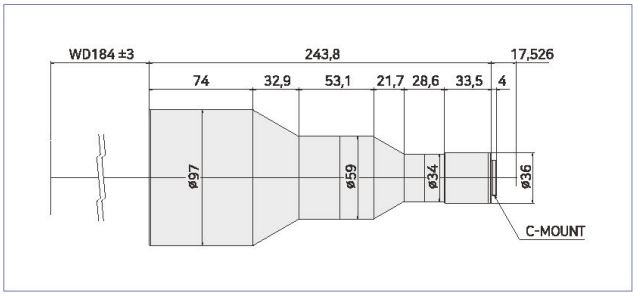
DTCL 0.12X-230-11

Standard & Precision Optics



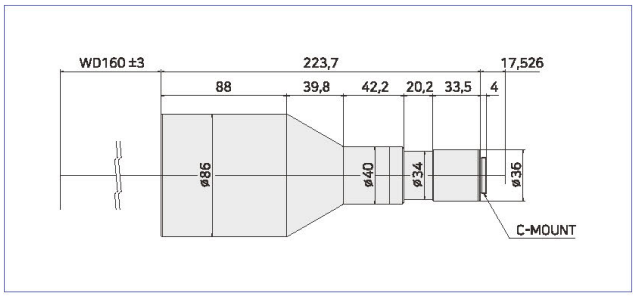
DTCL 0.138X-184-11

Standard & Precision Optics



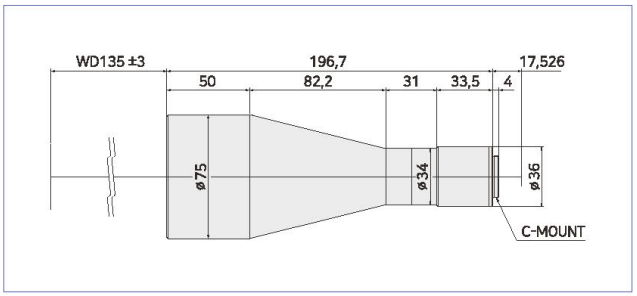
DTCL 0.157X-160-11

Standard & Precision Optics



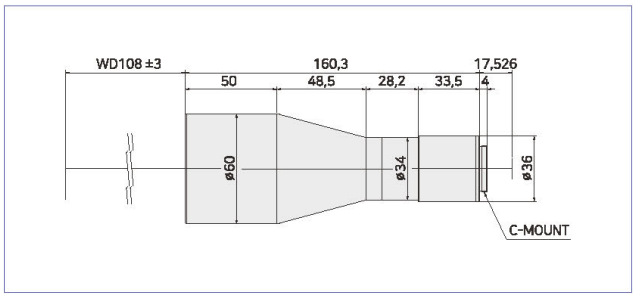
DTCL 0.184X-135-11

Standard & Precision Optics



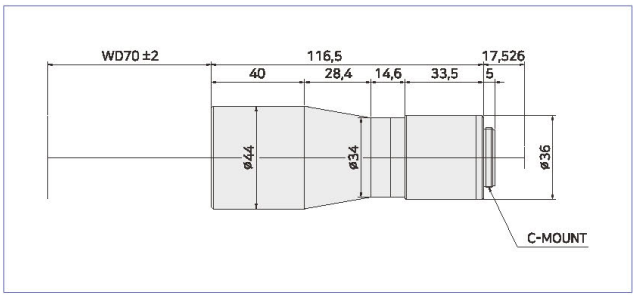
DTCL 0.24X-108-11

Standard & Precision Optics



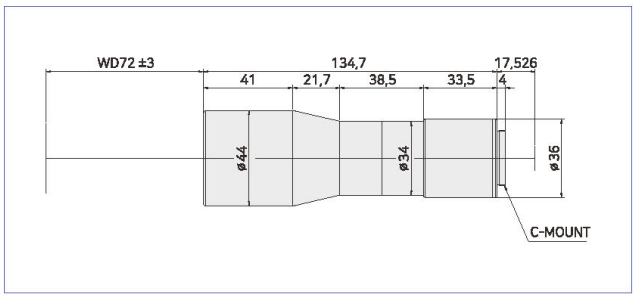
DTCL 0.255X-70-9

Standard & Precision Optics



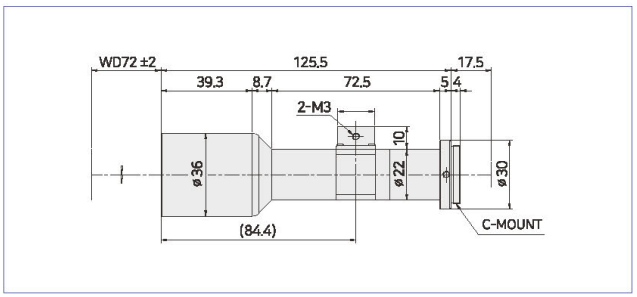
DTCL 0.35X-72-11

Standard & Precision Optics



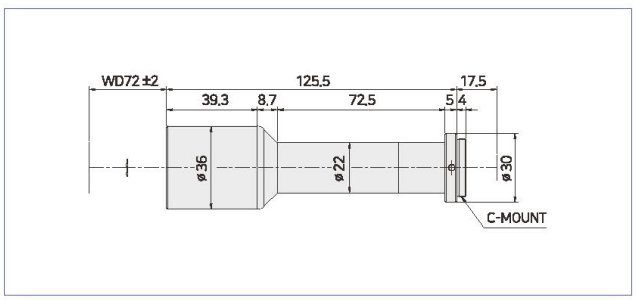
DTCL 0.5X-72D-11

Standard & Precision Optics



DTCL 0.5X-72-11

Standard & Precision Optics



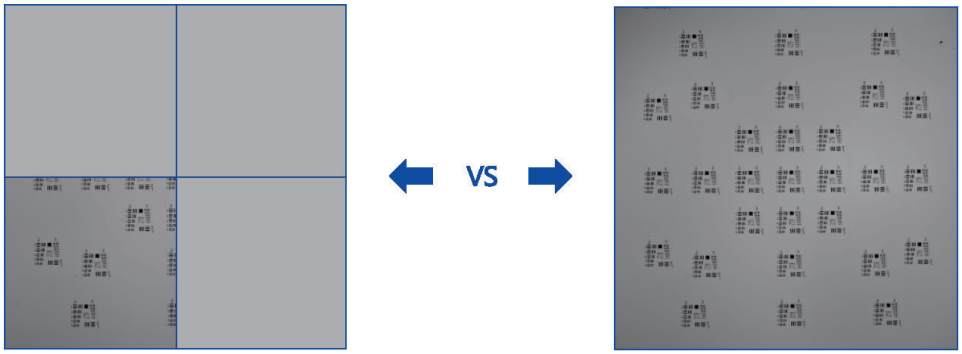
Standard & Precision Optics

TCL-25M Series

FEATURES

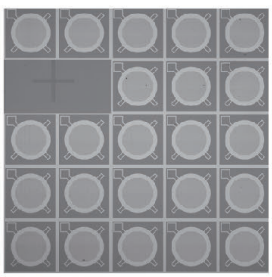
- Can support up to 25M Sensor which is 32㎜ diagonal length.
- Compatible with 12M Sensor according to the customer requirement.
- High Resolution lens & No perspective error over the whole F.O.V.
- Iris diaphragm adapted for adjusting D.O.F.
- Possible to change the mount according to Camera.

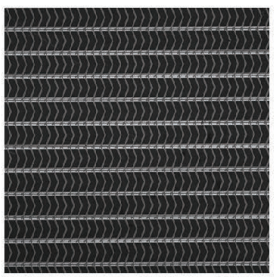
This lens is good for the large area inspection for wide F.O.V. It can get about 4X bigger image than 4M lens. Thus, It is possible to reduce the tact time and cost also increase the production efficiency while maintaining of the image quality.



4M Series　　25M Series

This series is really good for precise measurement like Wafer inspection (IC marking, reed and defect, scratch), SMT & PCB (via hole, component height & depth) and LED package (Wire bonding, die and chip size, defect) applications.
It is possible to apply for various applications according to magnification and W.D & illumination condition.





TCL-25M Series

* Remark : It is compatible with 12M / 25M CAMERA

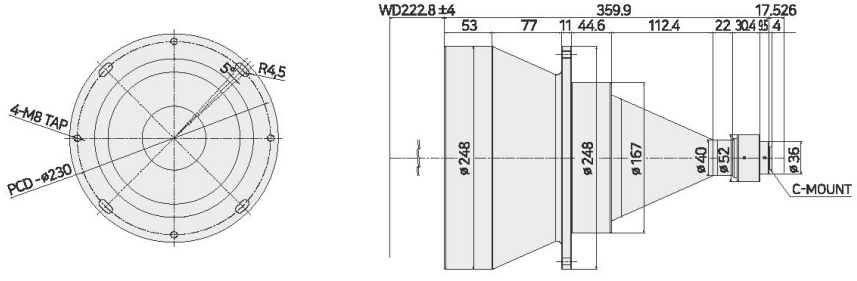
Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≤ degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.14X-220-12M	0.14X	220	38.563	0.0087	8	17.959㎜	0.06	0.08	12M(28.16㎜)	C
TCL 0.153X-220-25M	0.153X	220	35.3	0.01	8	12.3㎜	0.08	0.02	25M(32㎜)	M42
TCL 0.33X-347I-25M	0.33X	347	16.8	0.02	8.25	2.7㎜	0.02	0.02	25M(32㎜)	M48
TCL 0.35X-213I-25M	0.35X	213	14.4	0.0233	7.5	2.2㎜	0.08	0.08	25M(32㎜)	M48
TCL 0.44X-152/DI-25M	0.44X	152	11.9	0.028	8	1.5㎜	0.04	0.04	25M(32㎜)	F
TCL 0.45X-270I-25M	0.45X	270	9.3	0.036	6.25	1.1㎜	0.08	0.08	25M(32㎜)	F
TCL 0.46X-150I-25M	0.46X	150	10.2	0.033	7	1.2㎜	0.04	0.04	25M(32㎜)	M48
TCL 0.5X-157/DI-25M	0.5X	157	10.7	0.031	8	1.152㎜	0.04	0.03	25M(32㎜)	F
TCL 0.5X-237I-25M	0.5X	237	8.4	0.04	6.25	900	0.08	0.08	25M(32㎜)	M48
TCL 0.55X-200I-25M	0.55X	200	9	0.04	7.4	880	0.03	0.04	25M(32㎜)	F
TCL 0.55X-271/D-12M	0.55X	271	9.1	0.037	7.4	1㎜	0.01	0.01	12M(28㎜)	M48
TCL 0.6X-132I-25M	0.6X	132	7	0.048	6.25	625	0.04	0.04	25M(32㎜)	M48
TCL 0.785X-275/D-12M	0.785X	275	6.3	0.053	7.4	528	0.01	0.01	12M(28㎜)	M48
TCL 0.789X-220-25M	0.789X	220	5.52	0.0607	6.5	375.89	0.03	0.03	25M(32㎜)	F
TCL 0.8X-240I-25M	0.8X	240	6.3	0.0533	7.5	421	0.04	0.04	25M(32㎜)	F
TCL 0.82X-270I-25M	0.82X	270	6.1	0.0546	7.5	401	0.04	0.04	25M(32㎜)	F
TCL 0.92X-170I-25M	0.92X	170	5.2	0.064	7.2	306	0.03	0.03	25M(32㎜)	M48
TCL 1.2X-155I-25M	1.2X	155	4.2	0.08	7.5	187	0.03	0.03	25M(32㎜)	F
TCL 1.28X-125/DI-25M	1.28X	125	4.7	0.071	9	197	0.03	0.03	25M(32㎜)	F
TCL 1.35X-110I-25M	1.35X	110	4.5	0.075	9	178	0.01	0.01	25M(32㎜)	F
TCL 1.45X-105DI-25M	1.45X	105	4.86	0.069	10.5	179	0.03	0.03	25M(32㎜)	F
TCL 1.5X-88D-25M	1.5X	88	2.99	0.112	6.7	107.2	0.04	0.04	25M(32㎜)	F
TCL 1.5X-100DI-25M	1.5X	100	4.04	0.083	9	144	0.03	0.03	25M(32㎜)	F
TCL 1.5X-100I-25M	1.5X	100	4.5	0.075	10	160	0.03	0.03	25M(32㎜)	F
TCL 3.0X-78/D-25M	3.0X	78	3.4	0.1	15	60	0.04	0.03	25M(32㎜)	F

* D.O.F Calculation : Permissible of circle of confusion : 25M ▸ 18㎛, 12M ▸ 22㎛

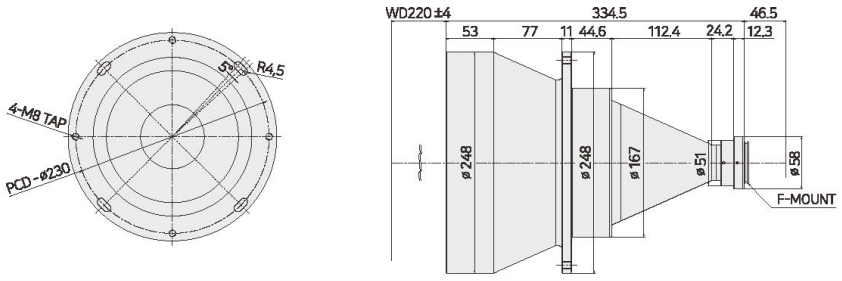
* Possible to change of mount

TCL 0.14X-220-12M

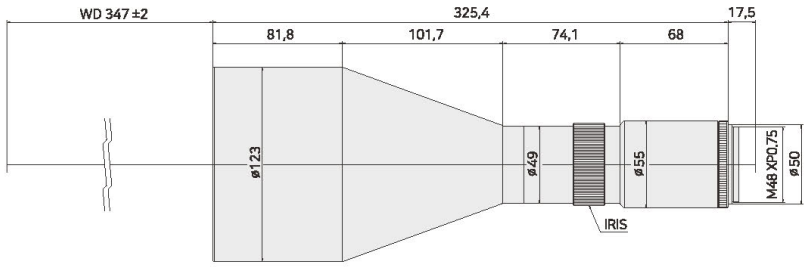
Standard & Precision Optics



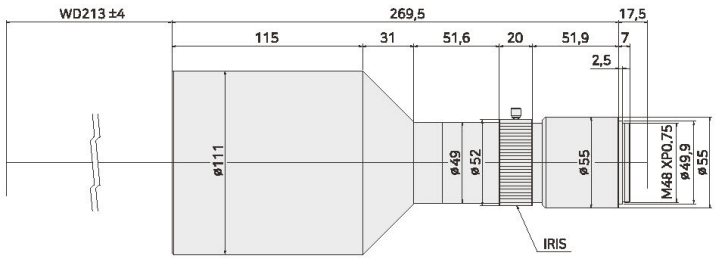
TCL 0.153X-220-25M



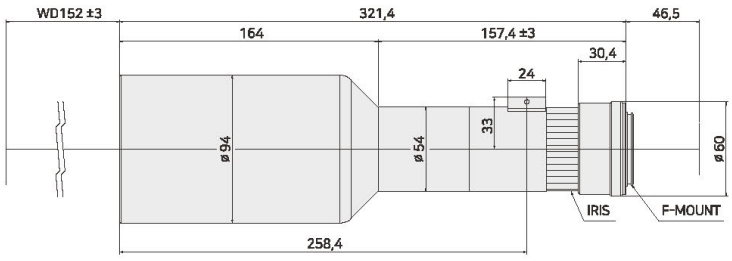
TCL 0.33X-347I-25M



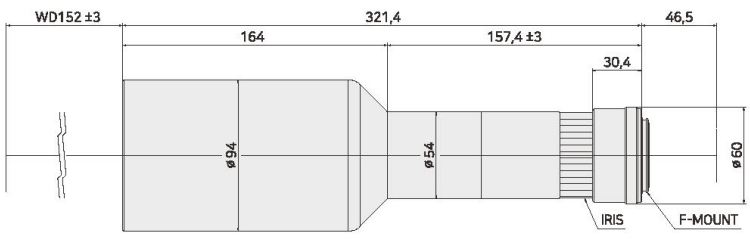
TCL 0.35X-213I-25M



TCL 0.44X-152DI-25M

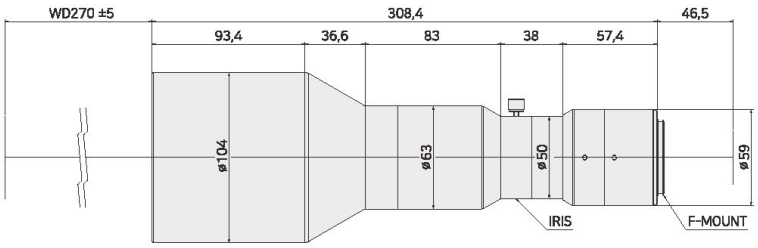


TCL 0.44X-152I-25M



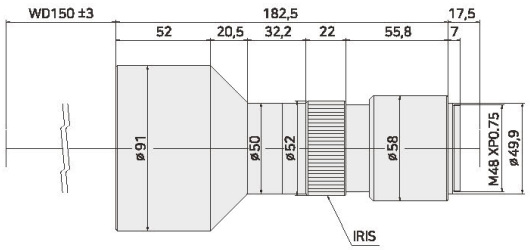
TCL 0.45X-270I-25M

Standard & Precision Optics



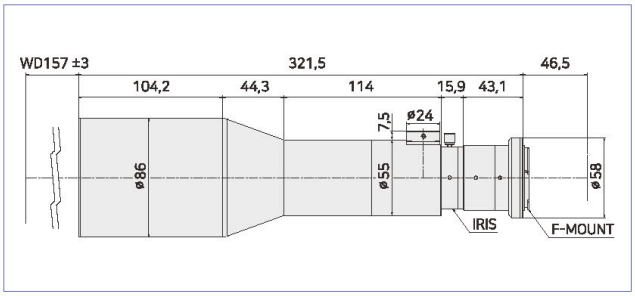
TCL 0.46X-150I-25M

Standard & Precision Optics



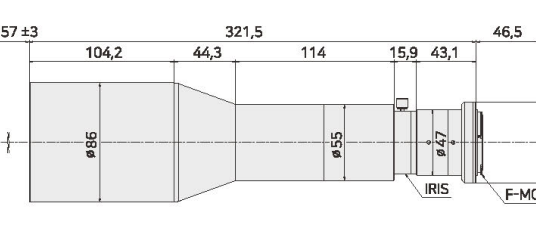
TCL 0.5X-157DI-25M

Standard & Precision Optics



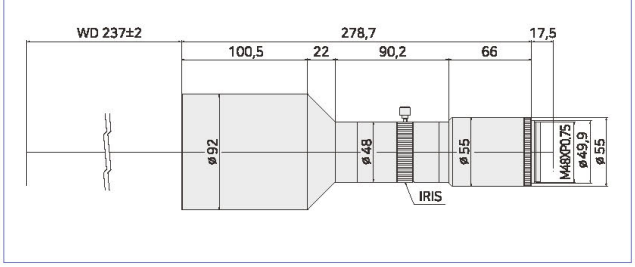
TCL 0.5X-157I-25M

Standard & Precision Optics



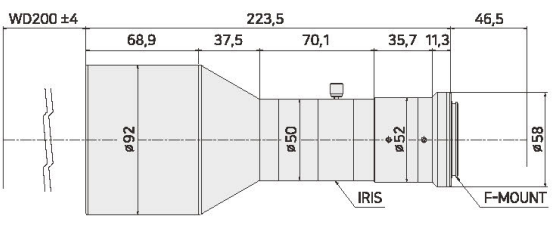
TCL 0.5X-237I-25M

Standard & Precision Optics



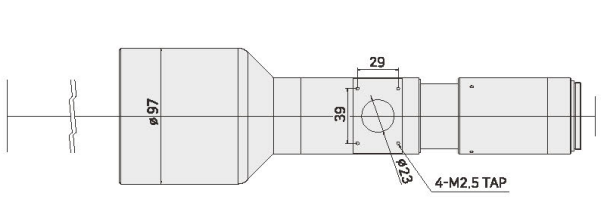
TCL 0.55X-200I-25M

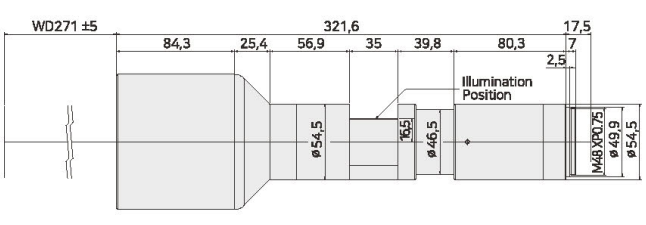
Standard & Precision Optics



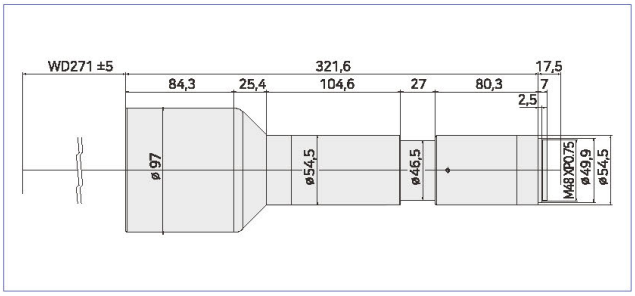
TCL 0.55X-271D-12M

Standard & Precision Optics

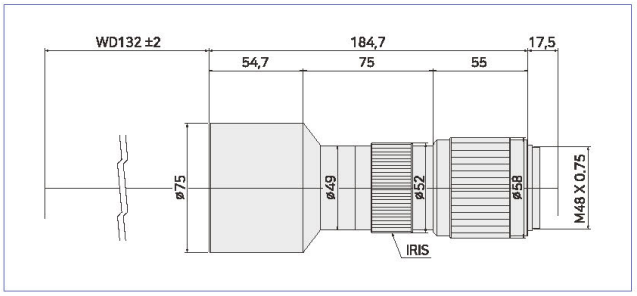




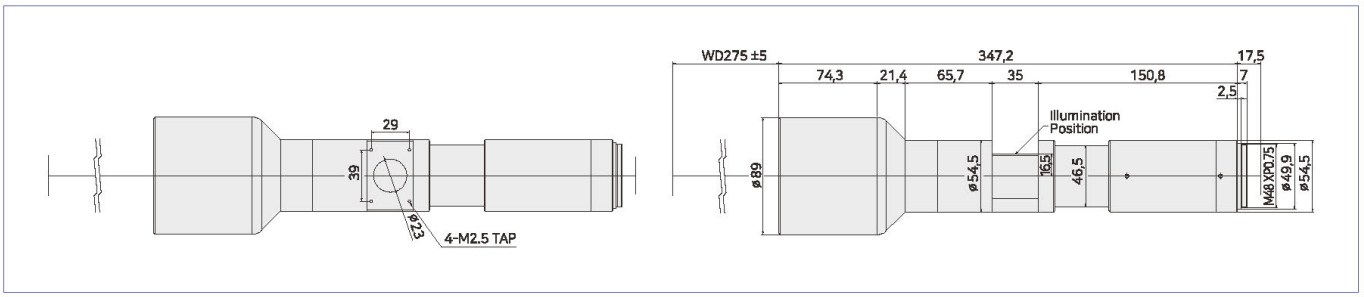
TCL 0.55X-271-12M



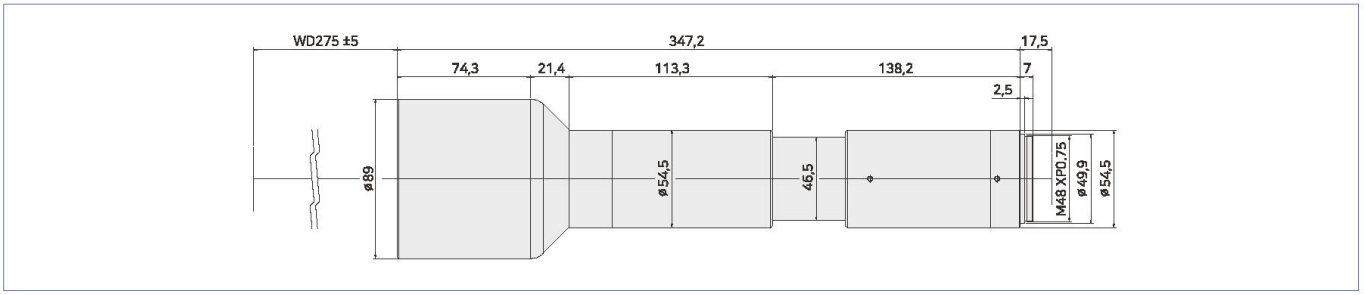
TCL 0.6X-132I-25M



TCL 0.785X-275D-12M



TCL 0.785X-275-12M



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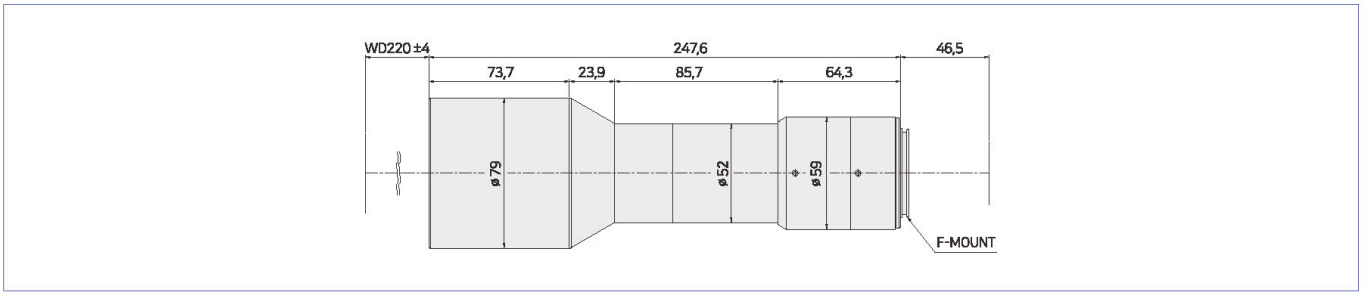
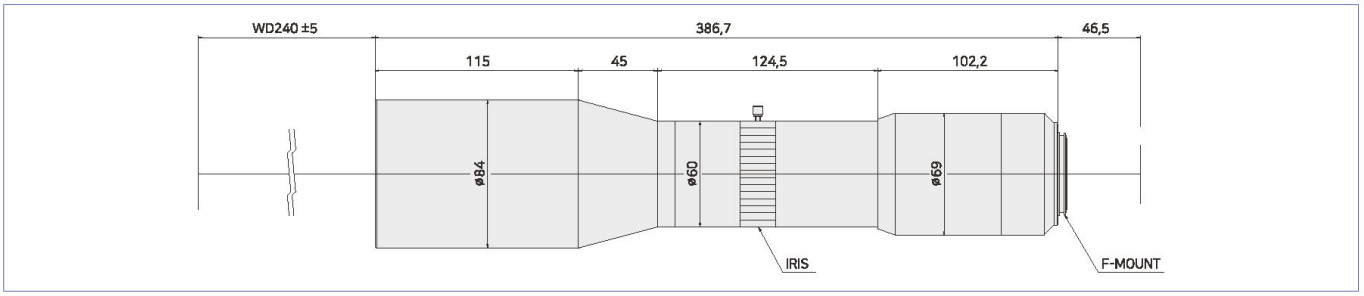
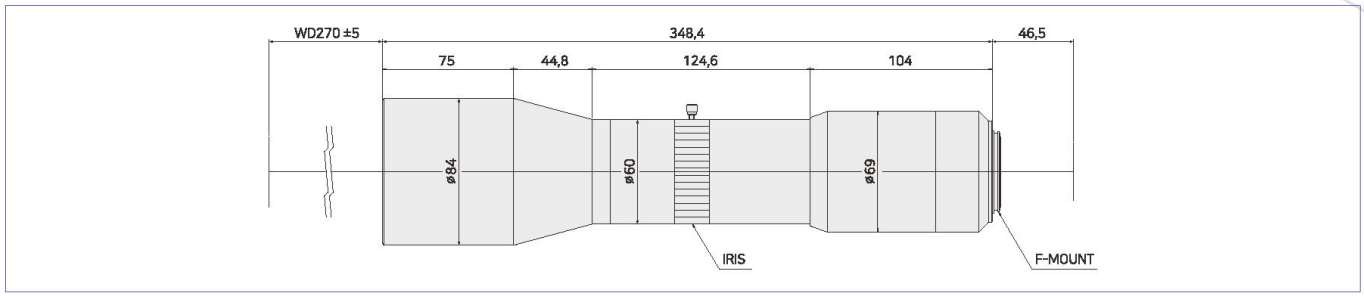


TCL 0.8X-240I-25M



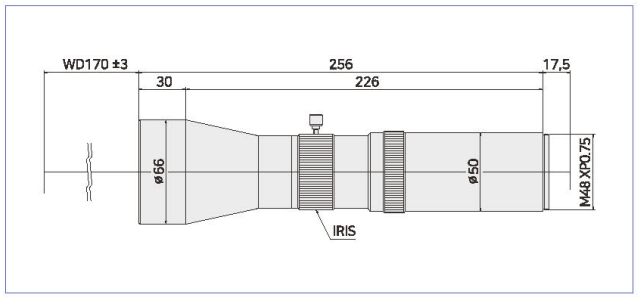
TCL 0.82X-270I-25M

Standard & Precision Optics



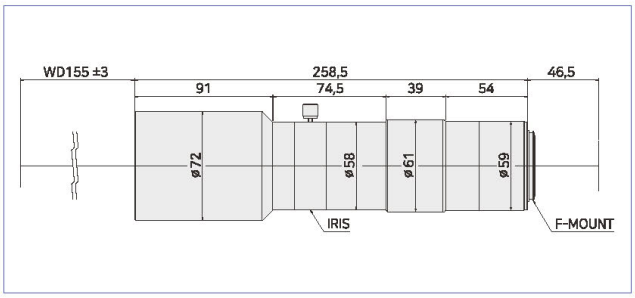
TCL 0.92X-170I-25M

Standard & Precision Optics



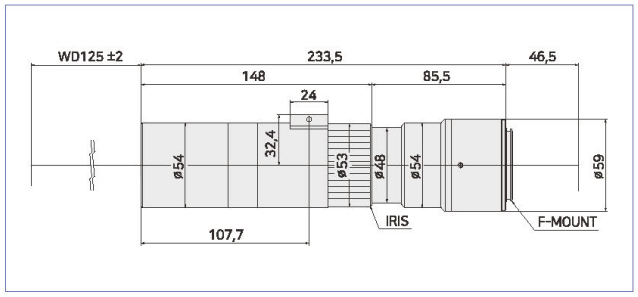
TCL 1.2X-155I-25M

Standard & Precision Optics



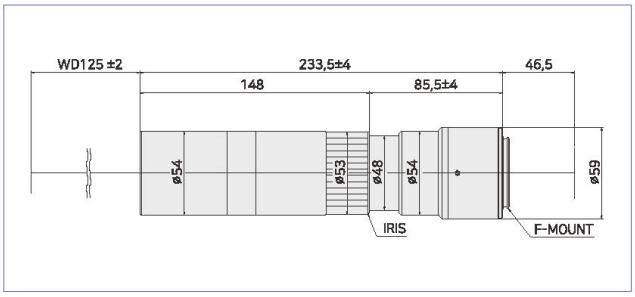
TCL 1.28X-125DI-25M

Standard & Precision Optics



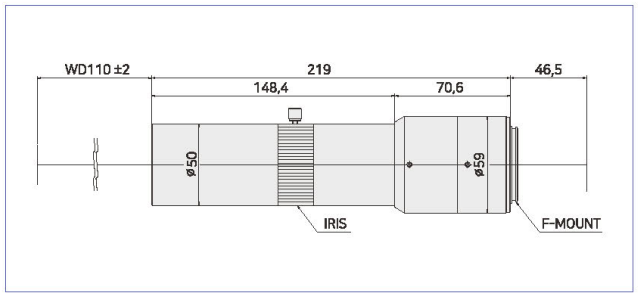
TCL 1.28X-125I-25M

Standard & Precision Optics



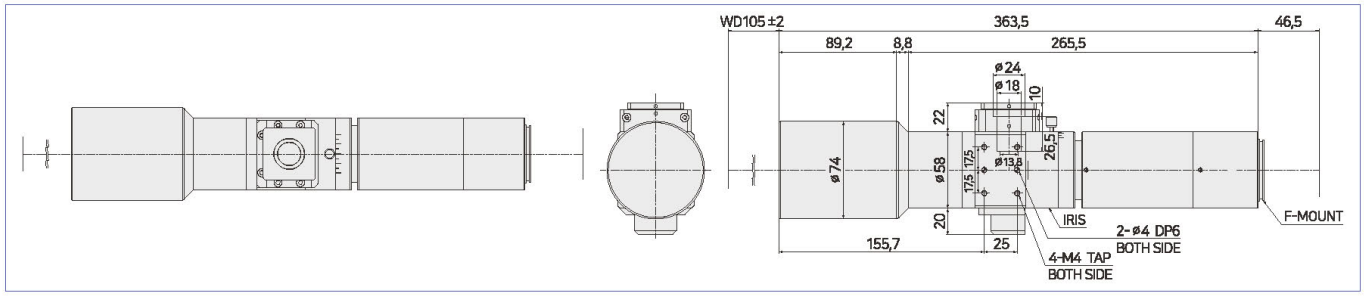
TCL 1.35X-110I-25M

Standard & Precision Optics

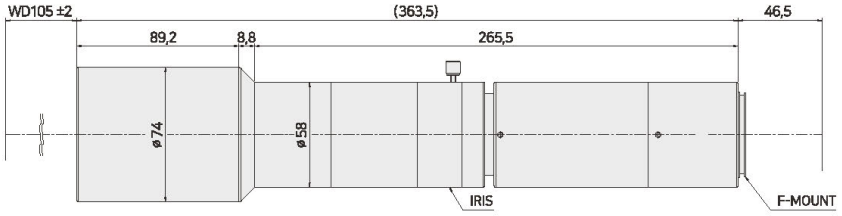


TCL 1.45X-105DI-25M

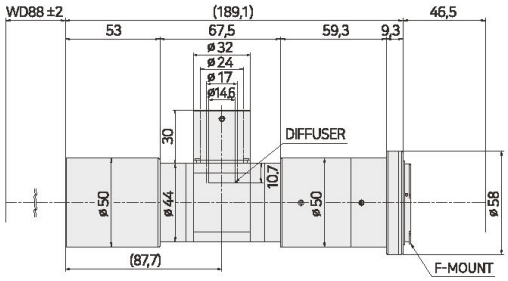
Standard & Precision Optics



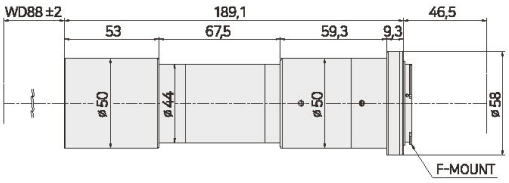
TCL 1.45X-105I-25M



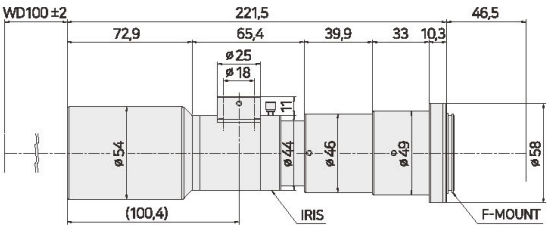
TCL 1.5X-88D-25M



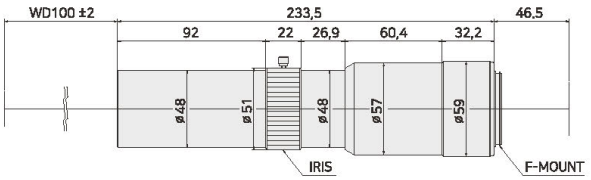
TCL 1.5X-88-25M



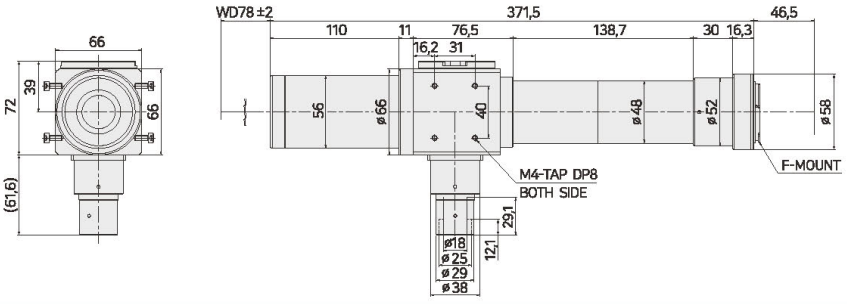
TCL 1.5X-100DI-25M



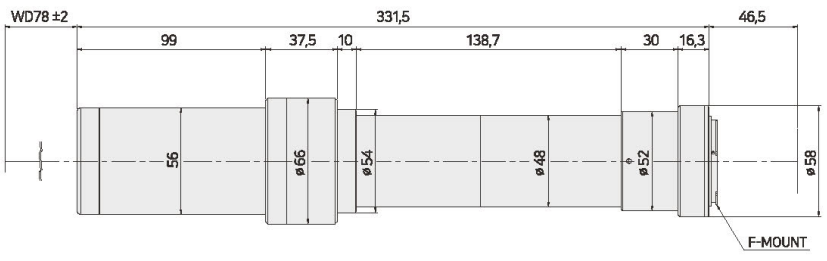
TCL 1.5X-100I-25M



TCL 3.0X-78D-25M



TCL 3.0X-78-25M



TCL-12M Series

FEATURES

- Suitable with small pixel size(3.45μm) and 12M@17.6㎜ sensor diagonal length.
- High contrast & resolution, low F/# regarding of all lenses.
- Iris diaphragm is adapted for adjusting the D.O.F.

There are presently demanded for small pixel size sensor and large F.O.V lens for the precise and high accuracy measurement in machine applications.
Customer wants to measure precise component and big specimen for one time.
These lenses have more big F.O.V. while maintaining the same quality.

Standard & Precision Optics

F.O.V & Image Quality Comparison | TCL 0.348X-130I-5M VS TCL 0.348X-130I-12M

5M camera(3.45μm) 12M camera(3.45μm)

TCL-12M Series lens is possible to measure FOV 1.6 times larger than TCL-5M Series lens.
Thus it is good for to reduce tact time and increase the productive efficiency.

TCL-12M Series

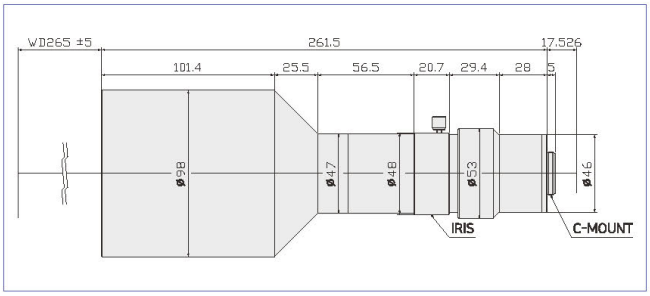
Model	Mag.	W.D (㎜)	Resolution (μm)	N.A	F/#	D.O.F (㎜)	Telecentricity (≤degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.318X-265I-12M	0.318X	265	10.6	0.0318	5	1.36	0.07	0.07	1.1"(17.52㎜)	C
TCL 0.348X-130I-12M	0.348X	130	12.1	0.0278	6.25	1.42	0.04	0.04	1.1"(17.52㎜)	C
TCL 0.348X-200I-12M	0.348X	200	12	0.029	6	1.36	0.02	0.02	1.1"(17.52㎜)	C
TCL 0.385X-132I-12M	0.385X	132	12.4	0.027	7.1	1.32	0.03	0.03	1.1"(17.52㎜)	C
TCL 0.49X-132I-12M	0.49X	132	7.5	0.0446	5.5	632.2μm	0.05	0.05	1.1"(17.52㎜)	C
TCL 0.5X-130I-12M	0.5X	130	9.4	0.0357	7	772.8μm	0.05	0.05	1.1"(17.52㎜)	C
TCL 0.5X-110/D-12M	0.5X	110	9.4	0.0357	7	772.8μm	0.04	0.03	1.1"(17.52㎜)	C
TCL 0.6X-130I-12M	0.6X	130	6.2	0.054	5.6	429.3μm	0.06	0.06	1.1"(17.52㎜)	C
TCL 0.64X-130I-12M	0.64X	130	5.8	0.0576	5.56	374.6μm	0.06	0.06	1.1"(17.52㎜)	C
TCL 0.7X-130I-12M	0.7X	130	5.1	0.066	5.3	298.5μm	0.06	0.06	1.1"(17.52㎜)	C
TCL 4.0X-110-12M	4.0X	110	2.1	0.16	12.5	21.5μm	0.05	0.04	1.1"(17.52㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 13.8μm

SPO has various 12M lenses according to magnification, W.D. Please contact us for any special lens if you need.
SPO will provide the best solution for various applications.

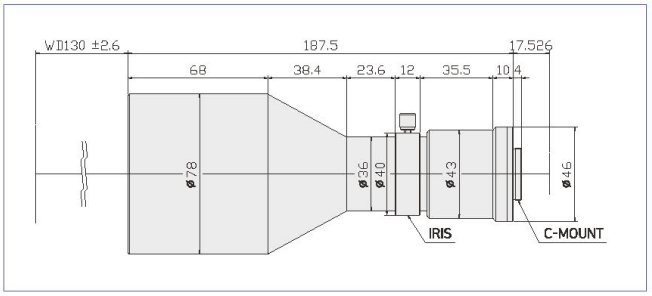
TCL 0.318X-265I-12M

Standard & Precision Optics



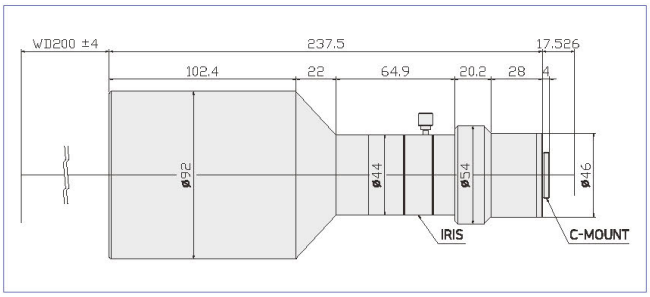
TCL 0.348X-130I-12M

Standard & Precision Optics



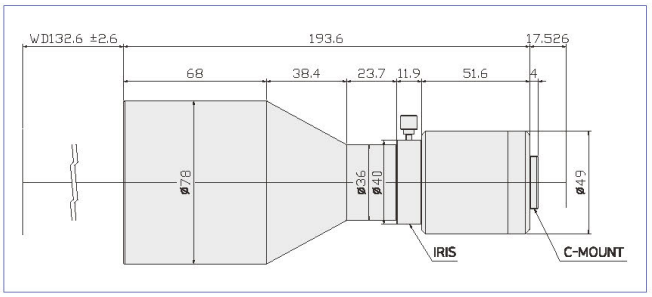
TCL 0.348X-200I-12M

Standard & Precision Optics



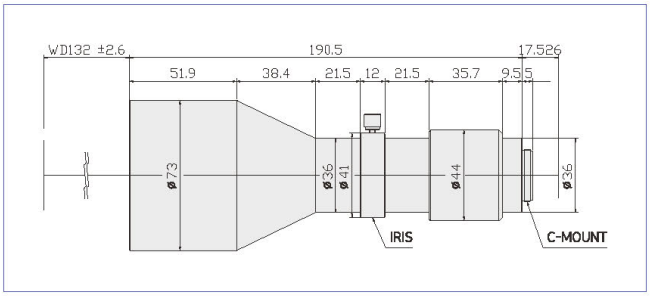
TCL 0.385X-132I-12M

Standard & Precision Optics



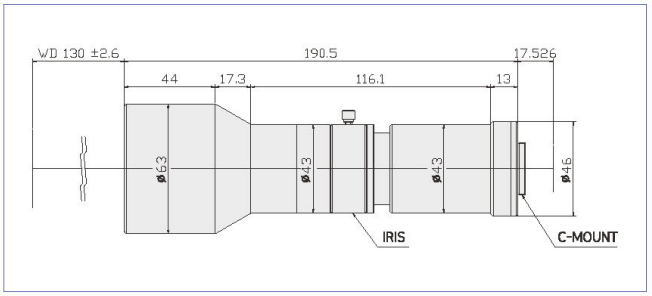
TCL 0.49X-132I-12M

Standard & Precision Optics



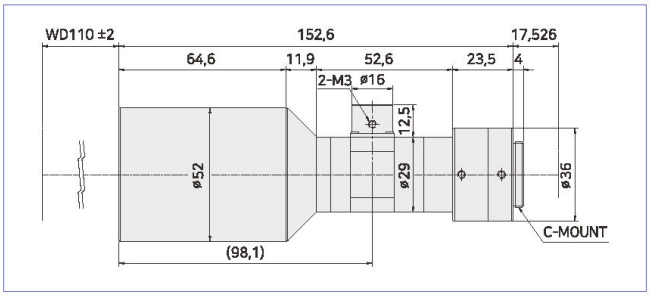
TCL 0.5X-130I-12M

Standard & Precision Optics



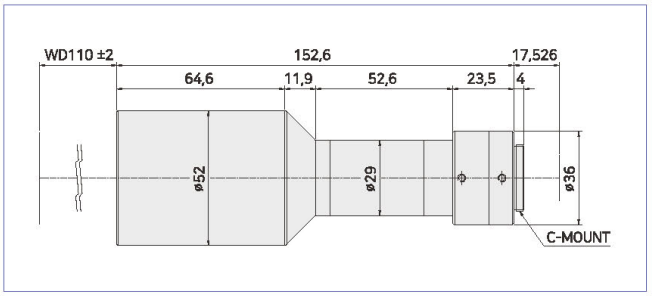
TCL 0.5X-110D-12M

Standard & Precision Optics



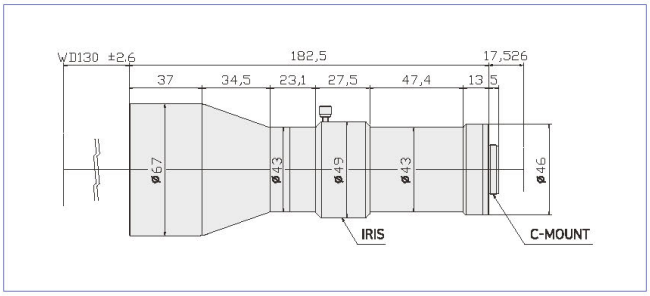
TCL 0.5X-110-12M

Standard & Precision Optics



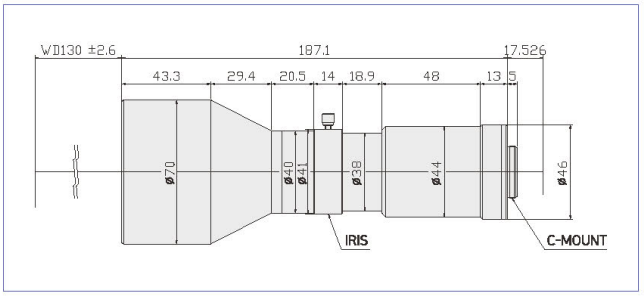
TCL 0.6X-130I-12M

Standard & Precision Optics



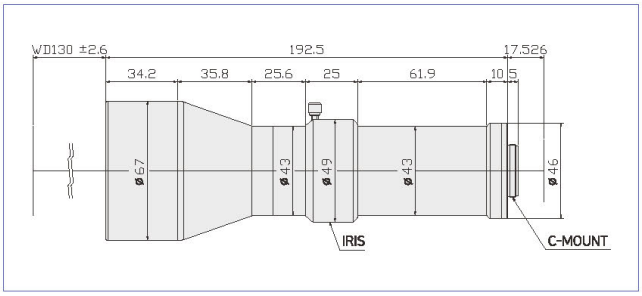
TCL 0.64X-130I-12M

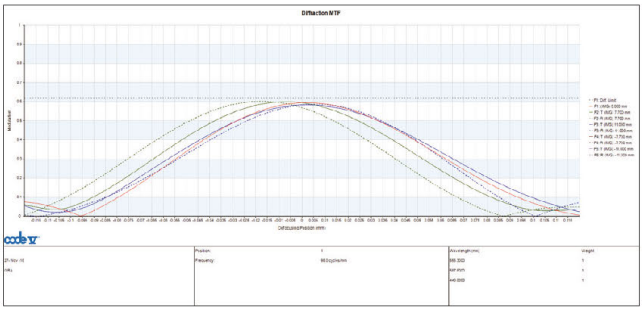
Standard & Precision Optics



TCL 0.7X-130I-12M

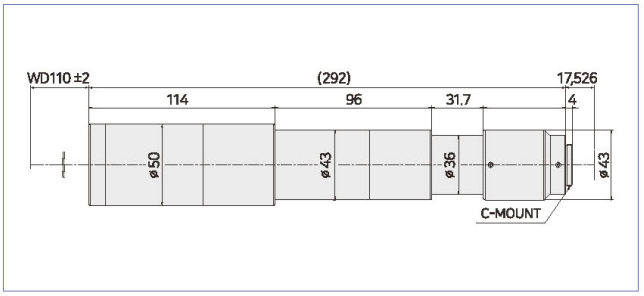
Standard & Precision Optics

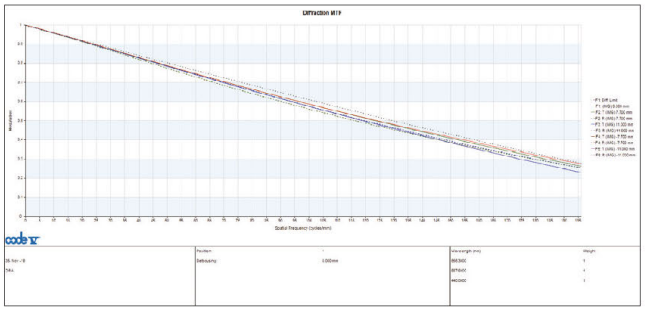




TCL 4.0X-110-12M

Standard & Precision Optics





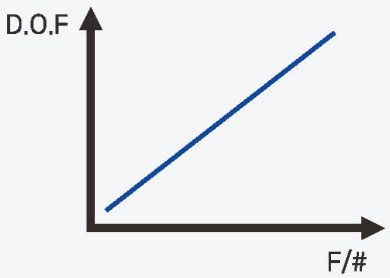
Standard & Precision Optics

D.O.F & Optical Specifications

Depth of field is the range which is the around the focal point of object side or image side in which the focal point is still sharp and focused.

- Ideal Depth of Field = 2 x [(Permissible circle of confusion x effective F/#) / M^2
- Permissible circle of confusion : Sensor Pixel Size x 4 (Area Sensor) & Sensor Pixel Size x 2 (Line Sensor)

ex) Case of Area Sensor(@Pixel Size =10㎛), F/# : 10, Mag : 1.0X D.O.F = 2 x [(40㎛ x 10) / 1^2] = 800㎛



Check point to increase of D.O.F

-. Check for the demand D.O.F

-. Check for the F/# value(it relates with each factors so F/# changed, all factors also will be changed simultaneously according to the optical formula.)

-. Check the image quality according to F/# variation.

According to increasing F/#, D.O.F will be increased, resolution and brightness of lens will be decreased. User has to note this point.

Standard & Precision Optics

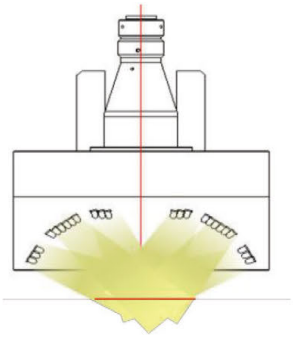
TCL-8M & 4M Series

FEATURES

- High resolution and high contrast design.
- Possible to support 4M (16㎜ diagonal length) to 8M (23㎜ diagonal length).
- Nearly zero distortion & high Telecentricity.
- Iris diaphragm for adjusting D.O.F.
  Possible to customize according to customer requirement.

It is highly recommended to the 2D & 3D precise measurement applications like SPI (Solder Paste Inspection) & AOI (Auto Optical Inspection) in the SMT & PCB application. These lenses have designed for large format sensor which have wide F.O.V. For example, SPI system measures the solder paste height, and defect & short circuit on the PCB after printed the solder paste on the board. Besides, AOI system inspects the reference position and defect of each component by pattern matching for optical image. It is also applied for LED components (die, wire bonding, chip size), Wafer inspection (IC chip, read, defect, etc.) applications.

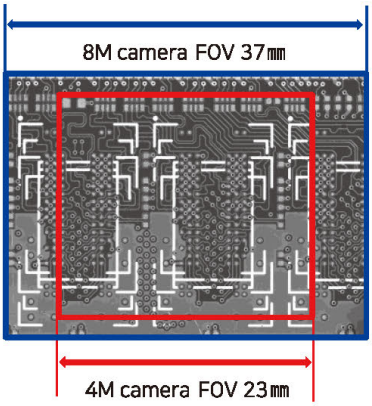
Standard mount is F-mount, but possible to change of the mount according to various cameras. There are wide range magnifications so you can choose a suitable lens for various applications.



System Schematic

TCL 0.49X-132I-8M-HR

F.O.V Comparison



These lenses can get higher pixel resolution and wide F.O.V via a large format telecentric lens. SPO have wide range magnifications so you can choose a suitable lens for various applications.

TIP Standard & Precision Optics

Use for 4M Camera (5.5㎛ * 5.5㎛ @ 2048 * 2048) + TCL 1.0X-65/D-4M-HR
- Pixel Resolution : 5.5㎛ / F.O.V. : 11.26㎜ * 11.26㎜

Use for 8M Camera (5.5㎛ * 5.5㎛ @ 3296 *2472) + TCL 1.0X-157I-8M-HR
- Pixel Resolution : 5.5㎛ / F.O.V. : 18.12㎜ * 13.6㎜

* Even if there is changed camera (4M to 8M), Pixel Resolution is maintained and then F.O.V will be widened!!!
  It is possible to get more widen image than reference image by changing camera.

TCL-8M Series

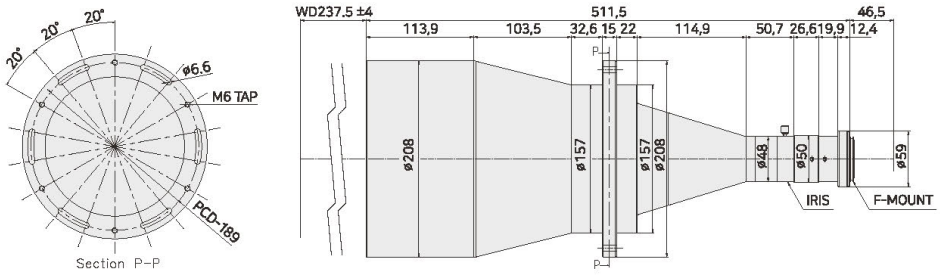
* Remark : It is compatible with 4M CCD

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Telecentricity (∼degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.15X-237.5-15M	0.15X	237.5	35.8	0.00937	8	15.6	0.04	0.03	15M(25㎜)	F
TCL 0.315X-130I-8M-HR	0.315X	130	13.3	0.0252	6.25	2.8	0.03	0.03	8M(23㎜)	F
TCL 0.318X-265I-8M-HR	0.318X	265	10.5	0.0318	5	2.2	0.03	0.08	8M(23㎜)	F
TCL 0.348X-130I-8M-HR	0.348X	130	12.1	0.0278	6.25	2.3	0.03	0.04	8M(23㎜)	F
TCL 0.348X-200I-8M-HR	0.348X	200	12	0.0289	6	2.2	0.03	0.02	8M(23㎜)	F
TCL 0.375X-265I-8M	0.375X	265	10	0.034	5.5	1.72	0.08	0.04	8M(23㎜)	F
TCL 0.385X-132I-8M-HR	0.385X	132	12.4	0.027	7.1	2.1	0.015	0.03	8M(23㎜)	F
TCL 0.409X-237I-15M	0.409X	237	10.3	0.036	6.25	1.345	0.03	0.06	15M(25㎜)	F
TCL 0.42X-132I-8M-HR	0.42X	132	5.4	0.0627	3.35	836㎛	0.03	0.03	8M(23㎜)	F
TCL 0.42X-130I-8M	0.42X	130	16	0.021	10	2.5	0.023	0.1	8M(23㎜)	F
TCL 0.49X-132I-8M-HR	0.49X	132	7.5	0.0446	5.5	1	0.03	0.05	8M(23㎜)	F
TCL 0.5X-130I-8M-HR	0.5X	130	9.4	0.0357	7	1.2	0.03	0.05	8M(23㎜)	F
TCL 0.56X-130I-8M	0.56X	130	12	0.028	10	1.4	0.03	0.06	8M(23㎜)	F
TCL 0.58X-254I-8M-HR	0.58X	254	5.8	0.058	5	654㎛	0.03	0.08	8M(23㎜)	F
TCL 0.6X-130I-8M-HR	0.6X	130	6.2	0.054	5.6	684㎛	0.03	0.06	8M(23㎜)	F
TCL 0.6X-130I-8M	0.6X	130	11.6	0.029	10.4	1.3	0.23	0.1	8M(23㎜)	F
TCL 0.6X-258I-8M-HR	0.6X	258	6	0.06	5	611㎛	0.03	0.03	8M(23㎜)	F
TCL 0.64X-130I-8M-HR	0.64X	130	5.8	0.0576	5.56	597㎛	0.02	0.06	8M(23㎜)	F
TCL 0.7X-130I-8M-HR	0.7X	130	5.1	0.066	5.3	476㎛	0.03	0.05	8M(23㎜)	F
TCL 0.7X-180I-15M	0.7X	180	5.7	0.0588	6	538㎛	0.04	0.03	15M(25㎜)	F
TCL 1.0X-157I-8M-HR	1.0X	157	4.7	0.071	7	308㎛	0.03	0.06	8M(23㎜)	F
TCL 2.0X-50/D-8M-HR	2.0X	50	3	0.112	8.9	98㎛	0.03	0.04	8M(23㎜)	F

* D.O.F Calculation : Permissible of circle of confusion : 8M ▸ 22㎛ * Possible to change of mount

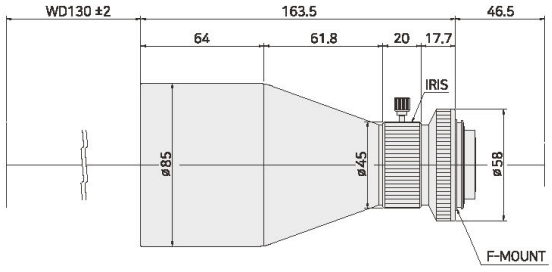
TCL 0.15X-237.5-15M

Standard & Precision Optics



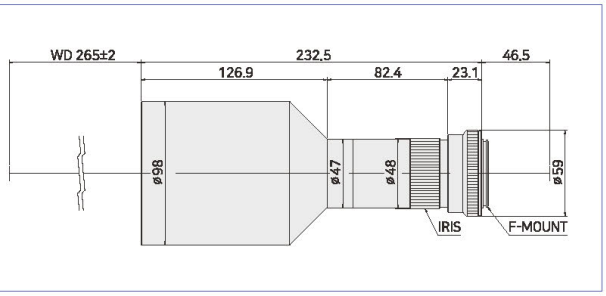
TCL 0.315X-130I-8M-HR

Standard & Precision Optics



TCL 0.318X-265I-8M-HR

Standard & Precision Optics



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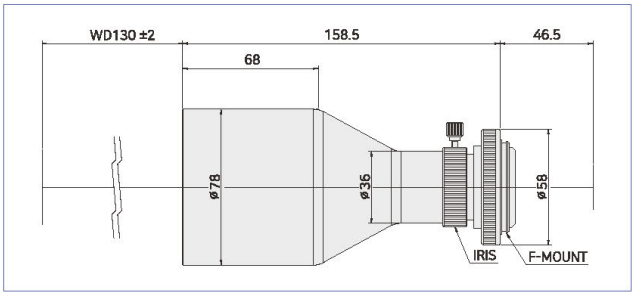

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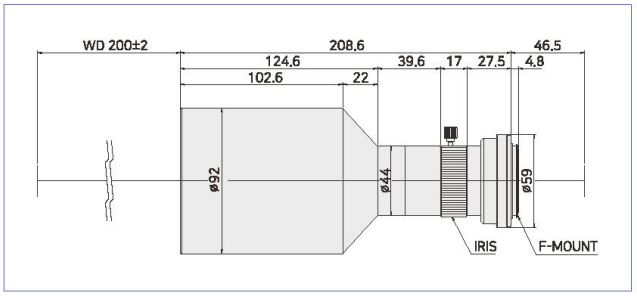
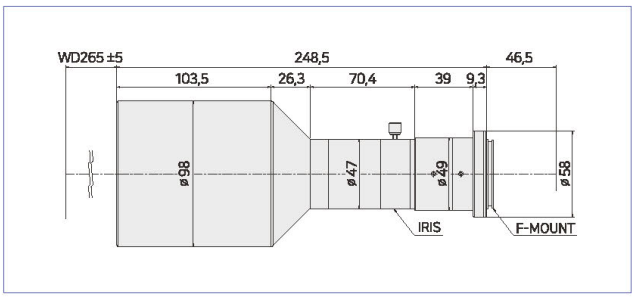
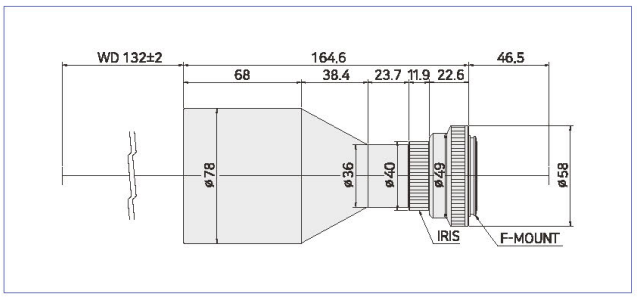


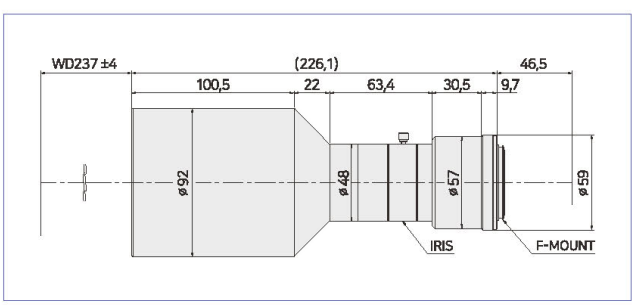
TCL 0.375X-265I-8M



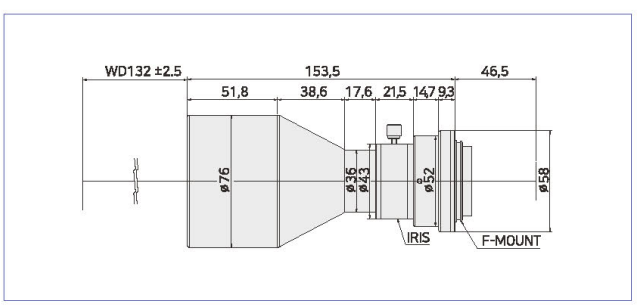
TCL 0.385X-132I-8M-HR



TCL 0.409X-237I-15M



TCL 0.42X-132I-8M-HR



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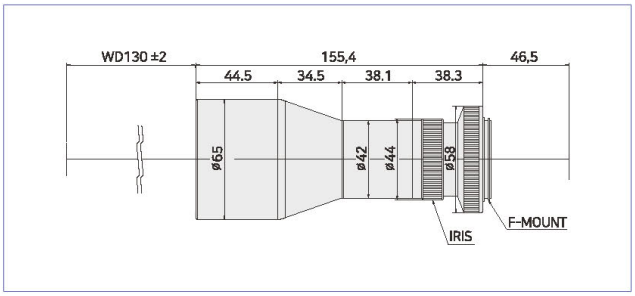
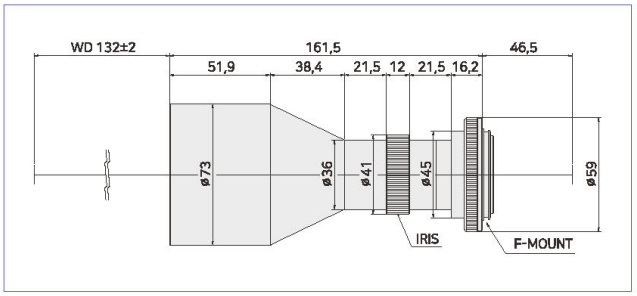
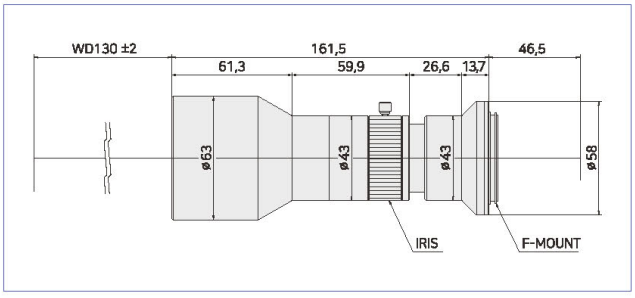


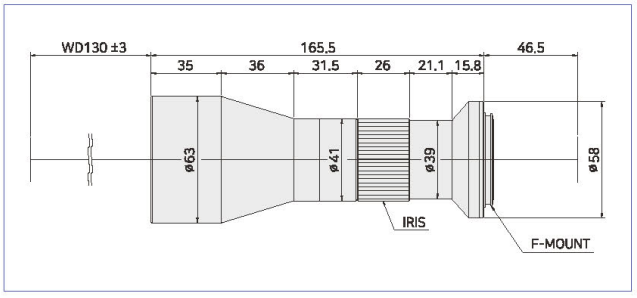
TCL 0.49X-132I-8M-HR



TCL 0.5X-130I-8M-HR

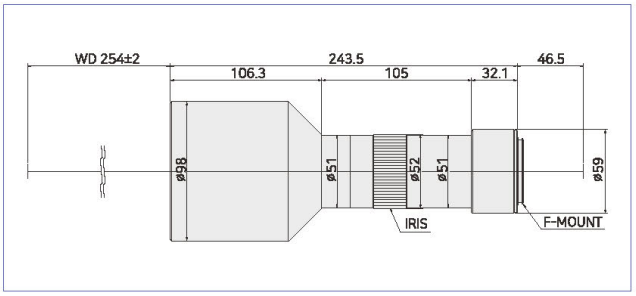


TCL 0.56X-130I-8M



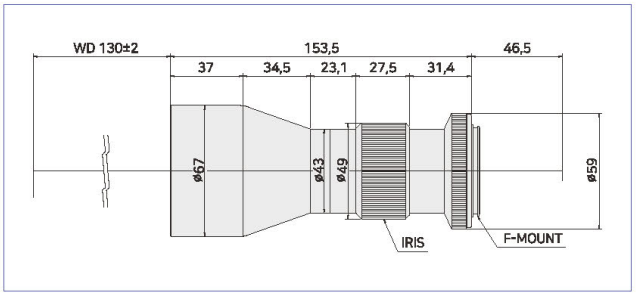
TCL 0.58X-254I-8M-HR

Standard & Precision Optics



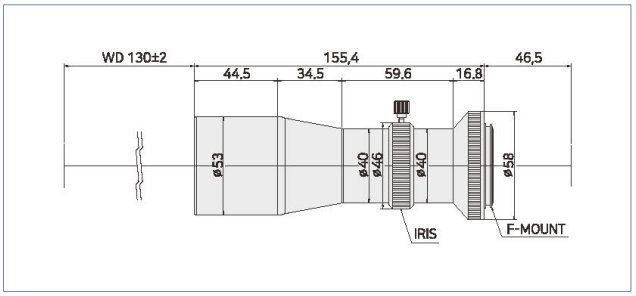
TCL 0.6X-130I-8M-HR

Standard & Precision Optics



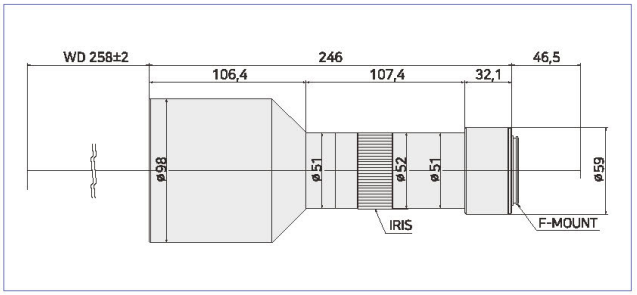
TCL 0.6X-130I-8M

Standard & Precision Optics



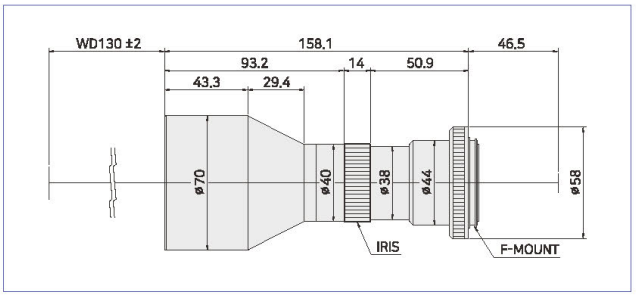
TCL 0.6X-258I-8M-HR

Standard & Precision Optics



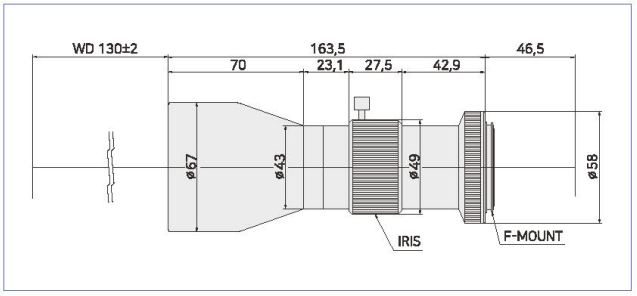
TCL 0.64X-130I-8M-HR

Standard & Precision Optics



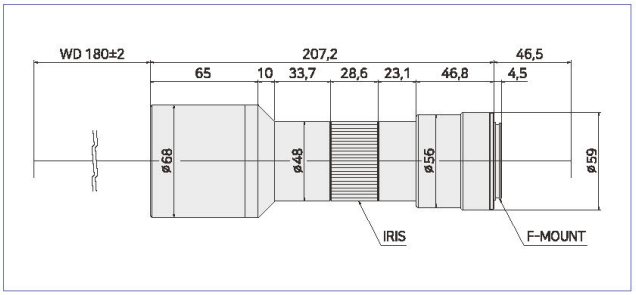
TCL 0.7X-130I-8M-HR

Standard & Precision Optics



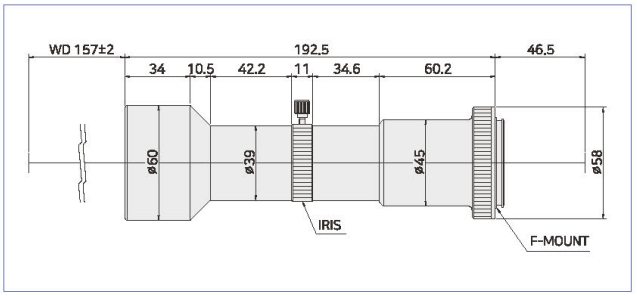
TCL 0.7X-180I-15M

Standard & Precision Optics



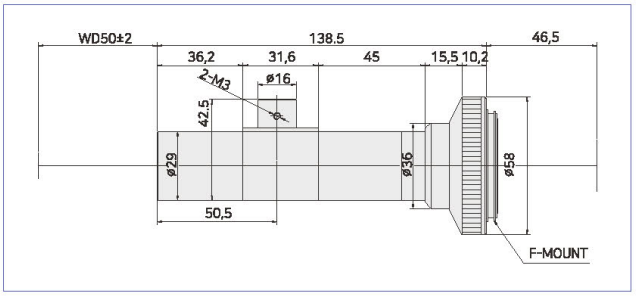
TCL 1.0X-157I-8M-HR

Standard & Precision Optics



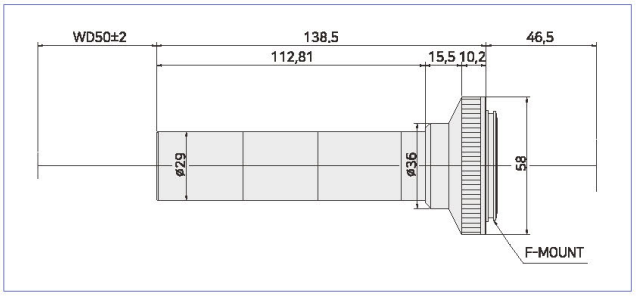
TCL 2.0X-50D-8M-HR

Standard & Precision Optics



TCL 2.0X-50-8M-HR

Standard & Precision Optics



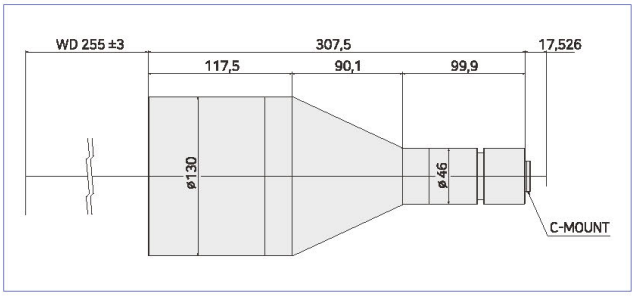
TCL-4M Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Telecentricity (≤degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.15X-255-4M-HR	0.15X	255	31.4	0.0107	7	13.7	0.023	0.01	1"(16㎜)	C
TCL 0.16X-240-4M-HR	0.16X	240	30.5	0.011	7.3	12.5	0.03	0.01	1"(16㎜)	C
TCL 0.215X-163I-4M	0.215X	163	17.6	0.019	5.7	5.4	0.03	0.03	1"(16㎜)	C
TCL 0.234X-130I-4M-HR	0.234X	130	16	0.021	5.6	4.5	0.03	0.03	1"(16㎜)	C
TCL 0.234X-200I-4M	0.234X	200	16	0.021	5.6	4.5	0.03	0.03	1"(16㎜)	C
TCL 0.26X-130I-4M-HR	0.26X	130	14.3	0.0234	5.5	3.6	0.03	0.03	1"(16㎜)	C
TCL 0.26X-200I-4M-HR	0.26X	200	14.3	0.0234	5.5	3.6	0.03	0.03	1"(16㎜)	C
TCL 0.275X-240I-4M-HR	0.275X	240	16.8	0.02	6.9	4	0.025	0.04	1"(16㎜)	C
TCL 0.312X-130I-4M-HR	0.312X	130	7.2	0.0465	3.3	1.5	0.03	0.03	1"(16㎜)	C
TCL 0.312X-200I-4M	0.312X	200	9.7	0.0346	4.5	2	0.03	0.03	1"(16㎜)	C
TCL 0.37X-240I-4M-HR	0.37X	240	12.1	0.0277	6.7	2.1	0.03	0.01	1"(16㎜)	C
TCL 0.445X-130I-4M-HR	0.445X	130	10.6	0.0318	7	1.5	0.023	0.065	1"(16㎜)	C
TCL 0.445X-200I-4M	0.445X	200	8.4	0.04	5.6	1.2	0.03	0.061	1"(16㎜)	C
TCL 0.5X-65/D-4M	0.5X	65	10.7	0.031	8	1.4	0.04	0.03	1"(16㎜)	C
TCL 0.6X-310I-4M-HR	0.6X	310	7	0.048	6.25	764㎛	0.03	0.08	1"(16㎜)	C
TCL 0.7X-65/D-4M	0.7X	65	6.6	0.051	6.9	610㎛	0.03	0.03	1"(16㎜)	C
TCL 0.8X-130/D-4M	0.8X	130	8.4	0.04	10	687㎛	0.03	0.03	1"(16㎜)	C
TCL 0.8X-160/D-4M	0.8X	160	6.7	0.05	8	550㎛	0.04	0.03	1"(16㎜)	C
TCL 0.8X-600/D-4M	0.8X	600	11.2	0.03	13.3	914㎛	0.03	0.05	1"(16㎜)	C
TCL 1.0X-65/D-4M	1.0X	65	5.4	0.062	8	352㎛	0.03	0.03	1"(16㎜)	C
TCL 1.0X-110/D-4M	1.0X	110	5.4	0.062	8	352㎛	0.03	0.03	1"(16㎜)	C
TCL 1.0X-130D-4M	1.0X	130	6.0	0.056	9	396㎛	0.03	0.03	1"(16㎜)	C
TCL 1.5X-65/D-4M	1.5X	65	3.4	0.0937	8	146㎛	0.03	0.03	1"(16㎜)	C
TCL 2.0X-65/D-4M	2.0X	65	3.3	0.10	10	110㎛	0.04	0.03	1"(16㎜)	C
TCL 2.0X-110/D-4M	2.0X	110	3.3	0.10	10	110㎛	0.04	0.03	1"(16㎜)	C
TCL 2.2X-40/D-4M-HR	2.2X	40	2.7	0.123	8.9	81㎛	0.03	0.02	1"(16㎜)	C
TCL 2.2X-50/D-4M	2.2X	50	2.5	0.135	8.1	74㎛	0.01	0.03	1"(16㎜)	C
TCL 3.0X-40/D-4M-HR	3.0X	40	2.4	0.14	10.7	52㎛	0.04	0.03	1"(16㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 22㎛

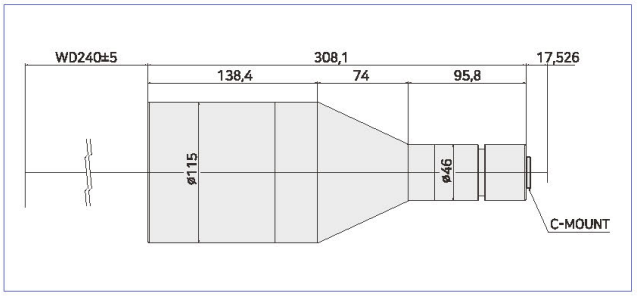
TCL 0.15X-255-4M-HR

Standard & Precision Optics



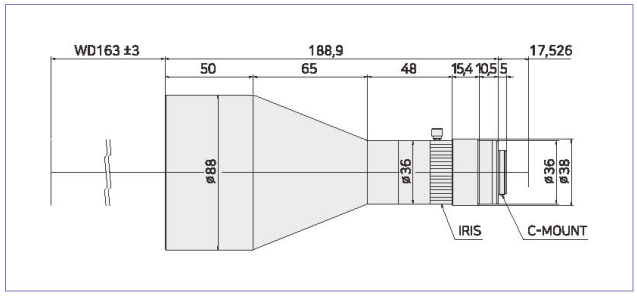
TCL 0.16X-240-4M-HR

Standard & Precision Optics



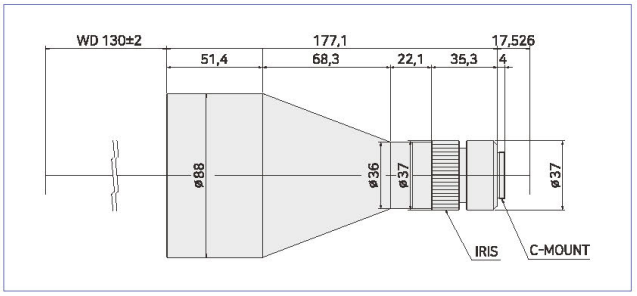
TCL 0.215X-163I-4M

Standard & Precision Optics



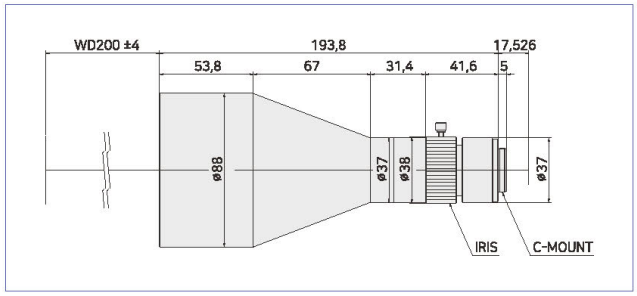
TCL 0.234X-130I-4M-HR

Standard & Precision Optics



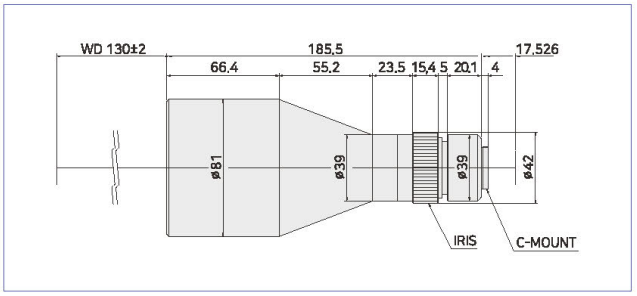
TCL 0.234X-200I-4M

Standard & Precision Optics



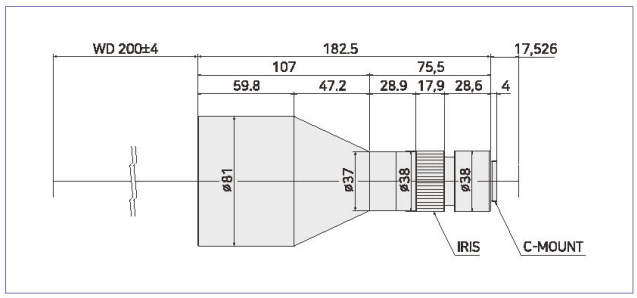
TCL 0.26X-130I-4M-HR

Standard & Precision Optics



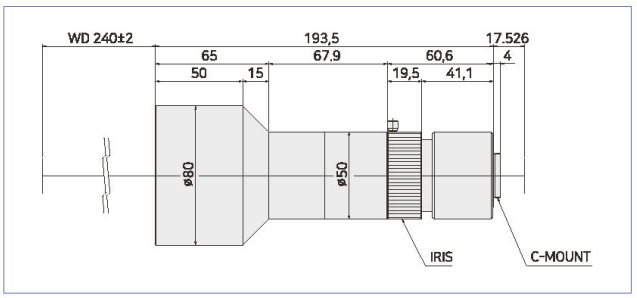
TCL 0.26X-200I-4M-HR

Standard & Precision Optics



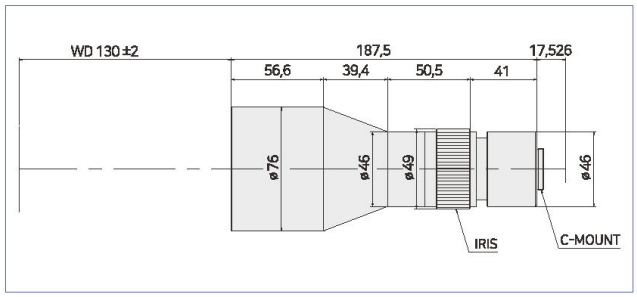
TCL 0.275X-240I-4M-HR

Standard & Precision Optics



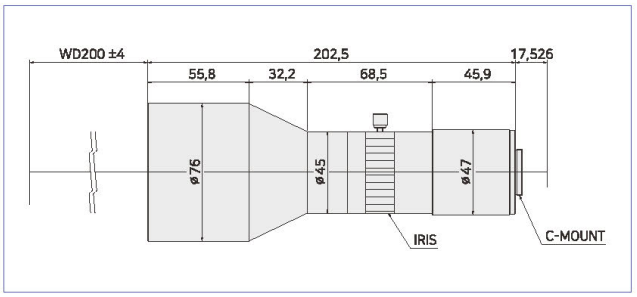
TCL 0.312X-130I-4M-HR

Standard & Precision Optics



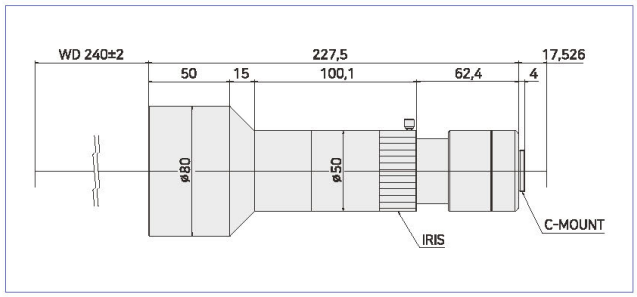
TCL 0.312X-200I-4M

Standard & Precision Optics



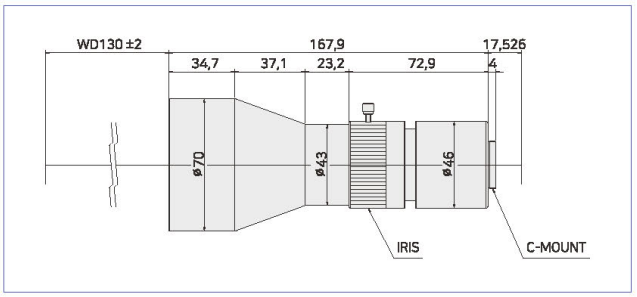
TCL 0.37X-240I-4M-HR

Standard & Precision Optics

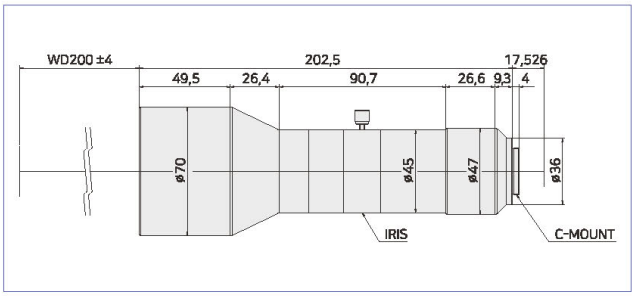


TCL 0.445X-130I-4M-HR

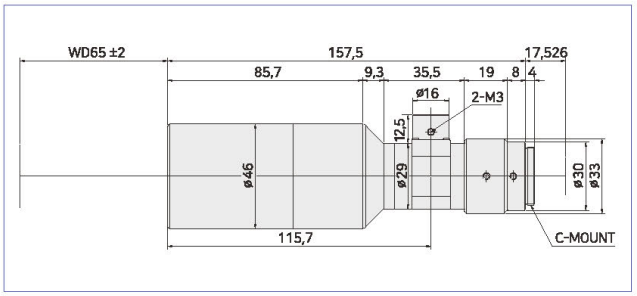
Standard & Precision Optics



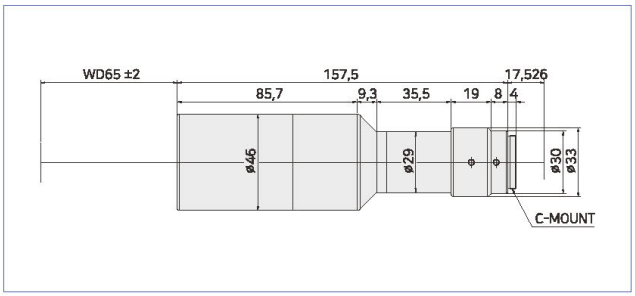
TCL 0.445X-200I-4M



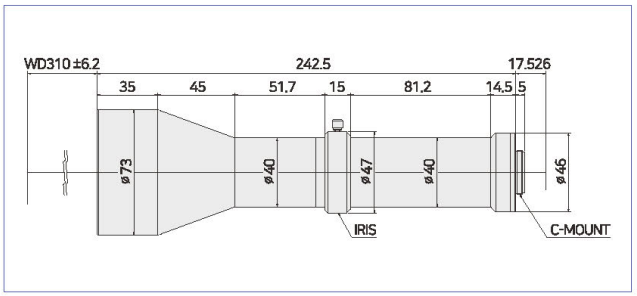
TCL 0.5X-65D-4M



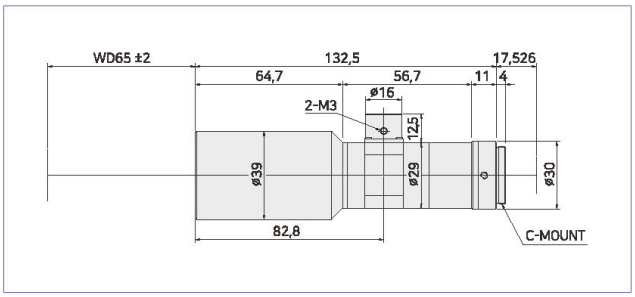
TCL 0.5X-65-4M



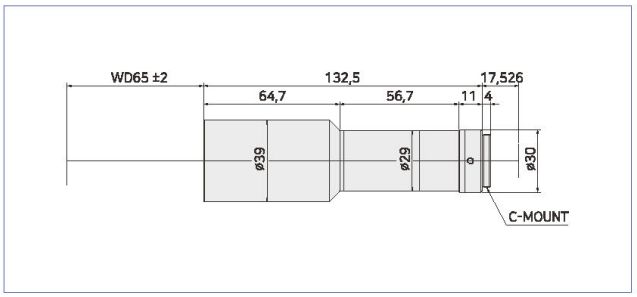
TCL 0.6X-310I-4M-HR



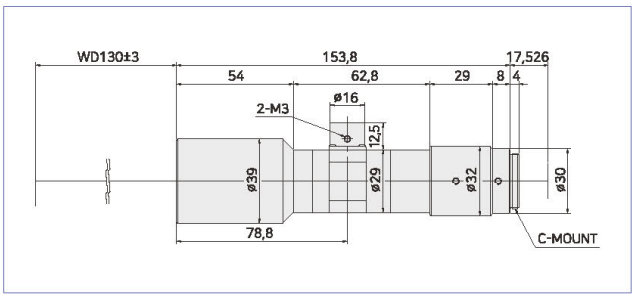
TCL 0.7X-65D-4M



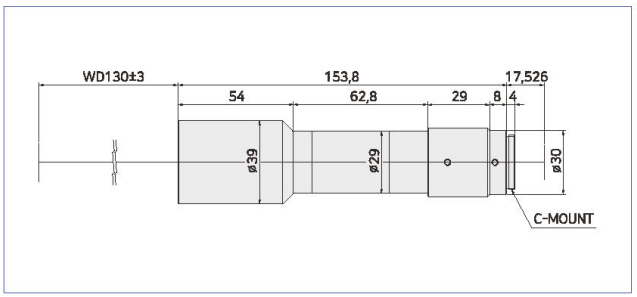
TCL 0.7X-65-4M



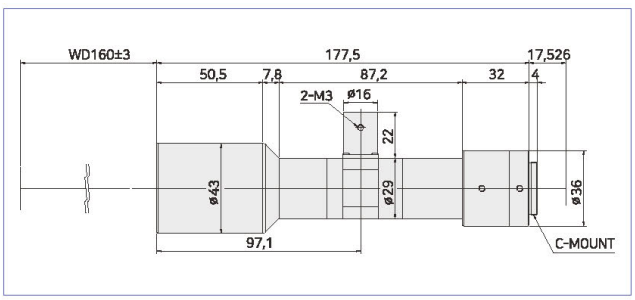
TCL 0.8X-130D-4M



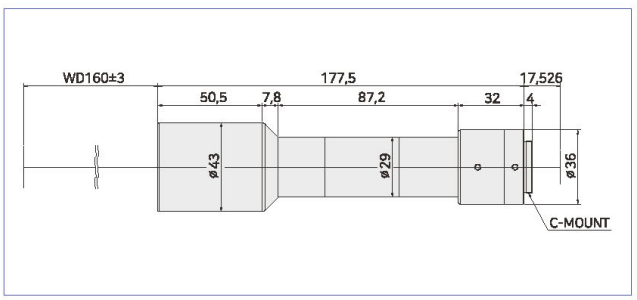
TCL 0.8X-130-4M



TCL 0.8X-160D-4M

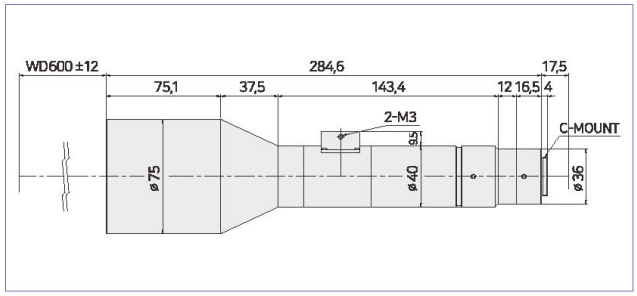


TCL 0.8X-160-4M



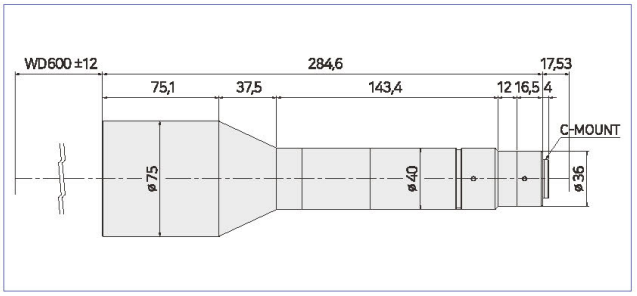
TCL 0.8X-600D-4M

Standard & Precision Optics



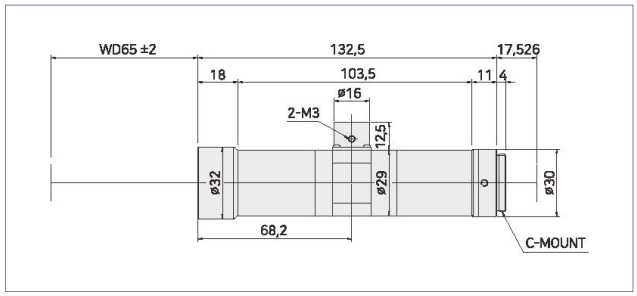
TCL 0.8X-600-4M

Standard & Precision Optics



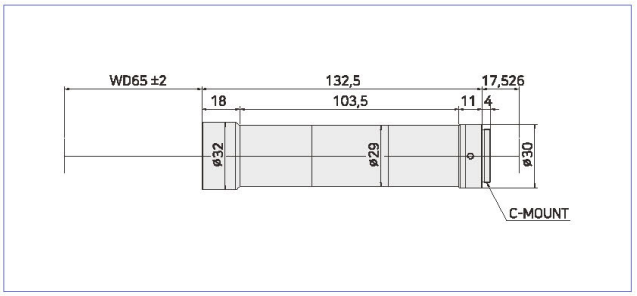
TCL 1.0X-65D-4M

Standard & Precision Optics



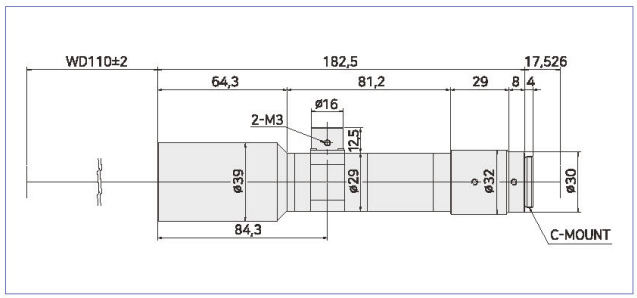
TCL 1.0X-65-4M

Standard & Precision Optics



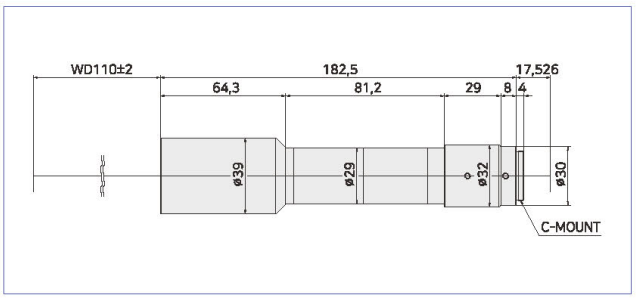
TCL 1.0X-110D-4M

Standard & Precision Optics



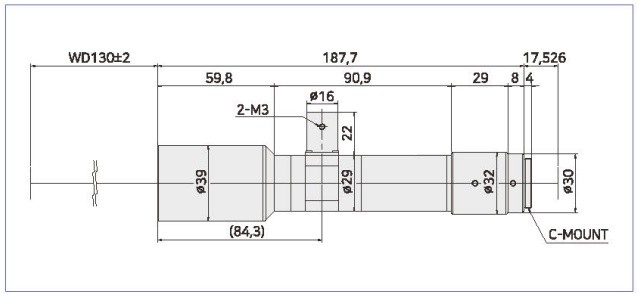
TCL 1.0X-110-4M

Standard & Precision Optics



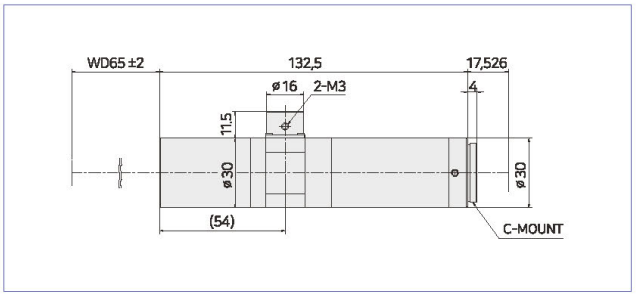
TCL 1.0X-130D-4M

Standard & Precision Optics



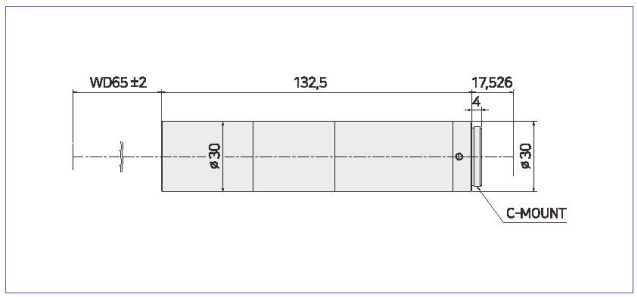
TCL 1.5X-65D-4M

Standard & Precision Optics



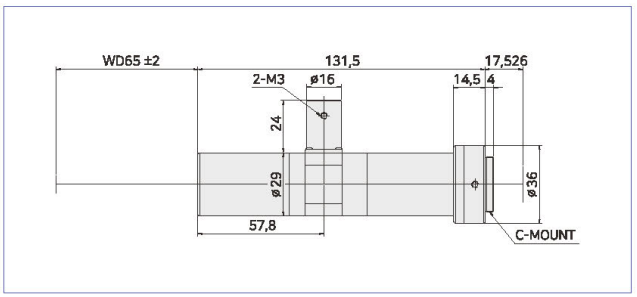
TCL 1.5X-65-4M

Standard & Precision Optics

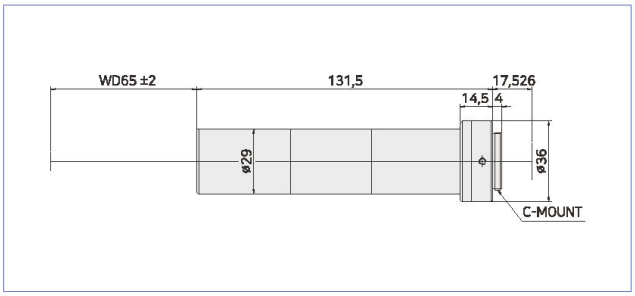


TCL 2.0X-65D-4M

Standard & Precision Optics



TCL 2.0X-65-4M



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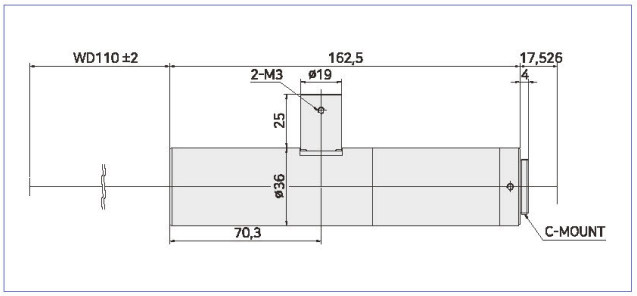
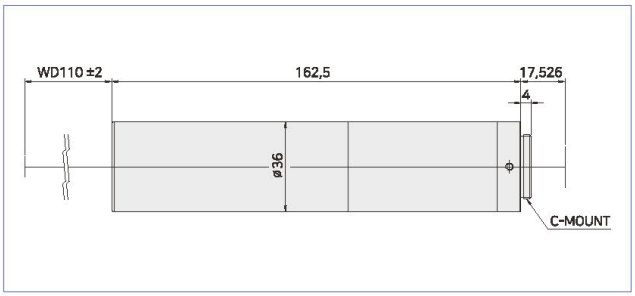
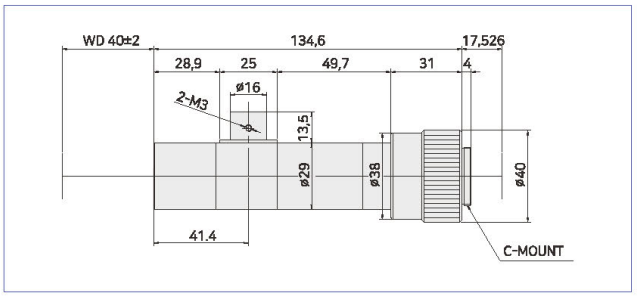


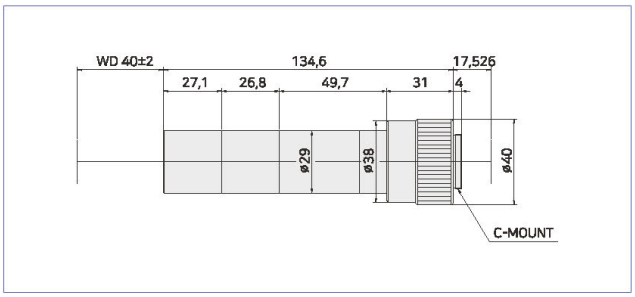
TCL 2.0X-110-4M



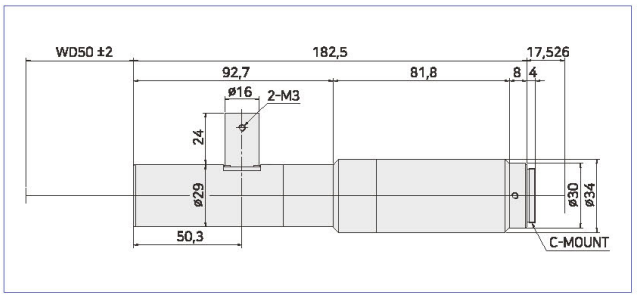
TCL 2.2X-40D-4M-HR



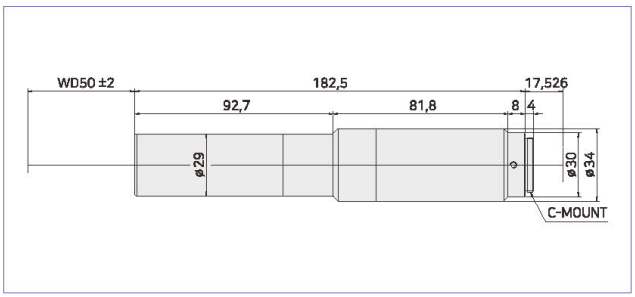
TCL 2.2X-40-4M-HR



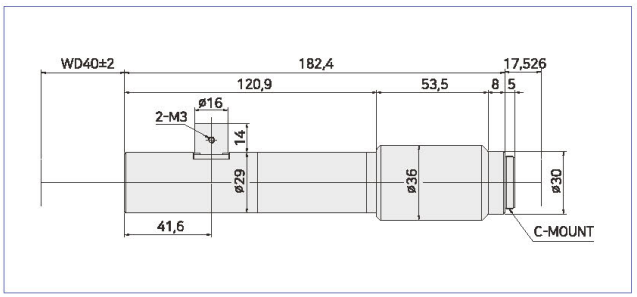
TCL 2.2X-50D-4M



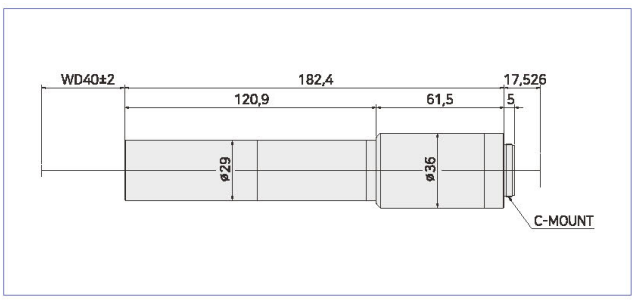
TCL 2.2X-50-4M



TCL 3.0X-40D-4M-HR



TCL 3.0X-40-4M-HR

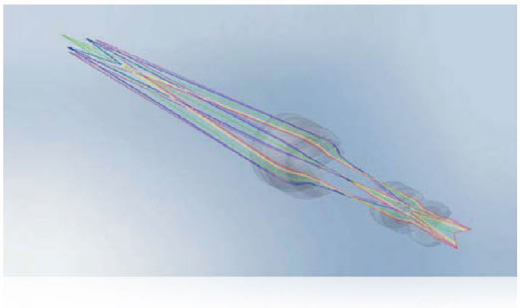


TCL-5M Series

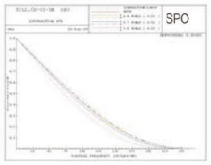
FEATURES

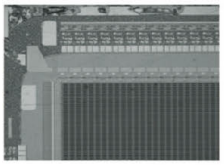
- Optimized design for 5M sensor camera (up to 2/3" camera & 3.45㎛/pixel) which is 11㎜ diagonal length.
- Not only ultra-high resolution and contrast with high N.A. but also compact design with coaxial illumination.
- Very low distortion in the whole field and lined up according to various W.D.

Customer can get the high-quality images by combination mega pixel camera and uniform coaxial illumination over the whole F.O.V also use variable "Iris" for the most lenses.

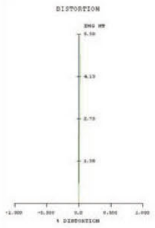


CCD : 5M Camera(3.45um/pixel)
Lens : TCL 2.0X-65D-5M



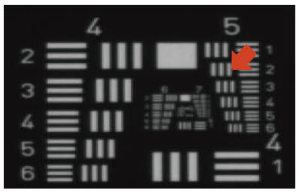


Distortionless



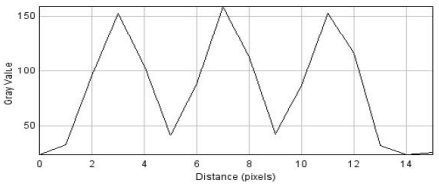
Standard & Precision Optics

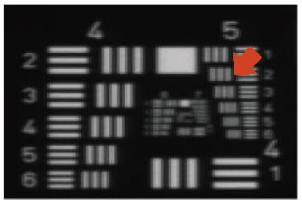
Image Comparison | TCL 0.5X-65/D-HR VS TCL 0.5X-65/D-5M



TCL 0.5X-65/D-5M

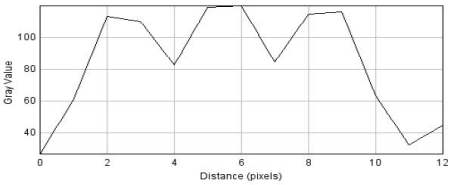
TCL 5M Series Lens

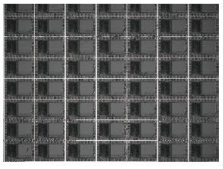


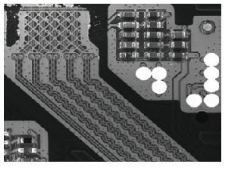


TCL 0.5X-65/D-HR

TCL HR Series Lens







TCL-5M Series have low F/# and High N.A where High contrast and High quality image.

SPO have various 5M lenses according to magnification and W.D.
Please, Ask to us for more special lens according to magnification and W.D.

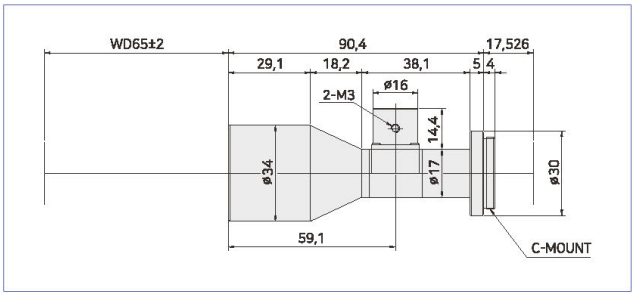
TCL-65-5M Series | W.D : 65㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (∝degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.5X-65/D-5M	0.5X	65	8.4	0.04	6.25	690	0.02	0.03	2/3"(11㎜)	C
TCL 0.8X-65/D-5M	0.8X	65	5.2	0.064	6.25	269	0.02	0.13	2/3"(11㎜)	C
TCL 1.0X-65/D-5M	1.0X	65	4.8	0.07	7.1	195	0.022	0.16	2/3"(11㎜)	C
TCL 2.0X-65/D-5M	2.0X	65	2.8	0.12	8.3	57	0.03	0.02	2/3"(11㎜)	C
TCL 2.0X-65/DI-5M										
TCL 3.0X-65/D-5M	3.0X	65	2.2	0.156	9.6	29	0.02	0.05	2/3"(11㎜)	C
TCL 3.0X-65/DI-5M										
TCL 4.0X-65/D-5M	4.0X	65	2.1	0.16	12.5	21	0.02	0.03	2/3"(11㎜)	C
TCL 4.0X-65/DI-5M										

* D.O.F Calculation : Permissible of circle of confusion : 13.8㎛

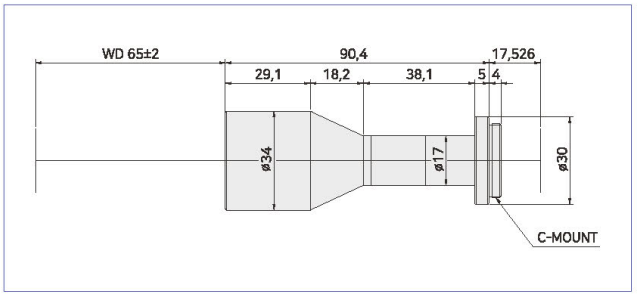
TCL 0.5X-65D-5M

Standard & Precision Optics



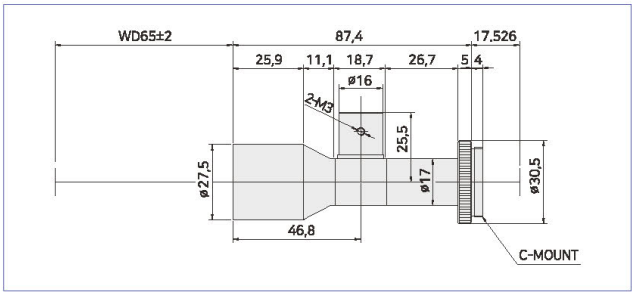
TCL 0.5X-65-5M

Standard & Precision Optics



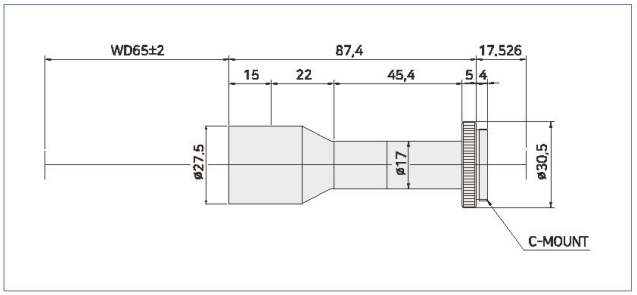
TCL 0.8X-65D-5M

Standard & Precision Optics



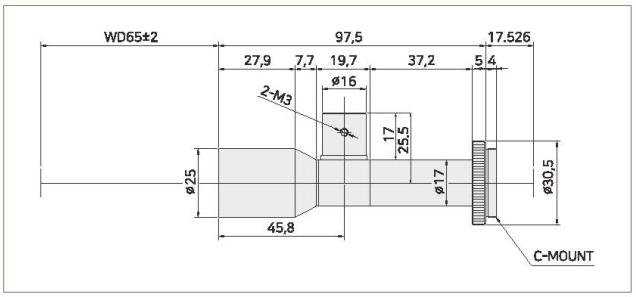
TCL 0.8X-65-5M

Standard & Precision Optics



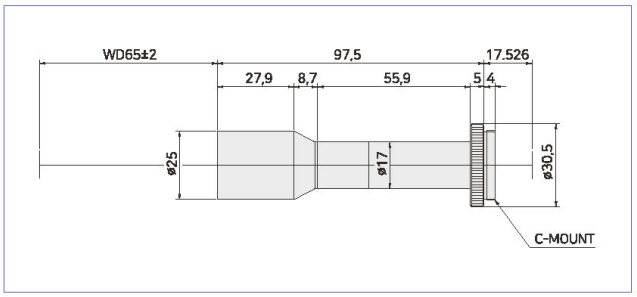
TCL 1.0X-65D-5M

Standard & Precision Optics



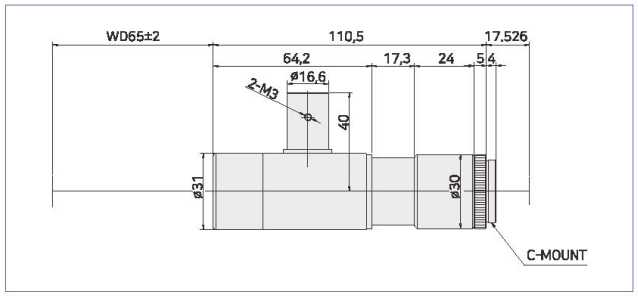
TCL 1.0X-65-5M

Standard & Precision Optics



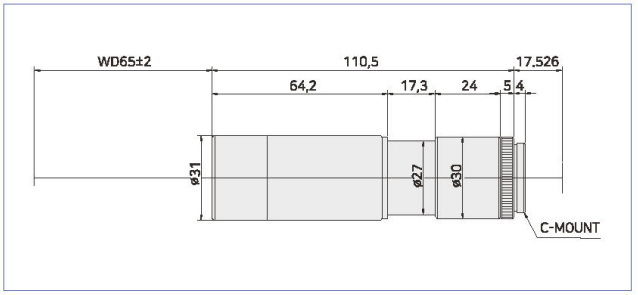
TCL 2.0X-65D-5M

Standard & Precision Optics



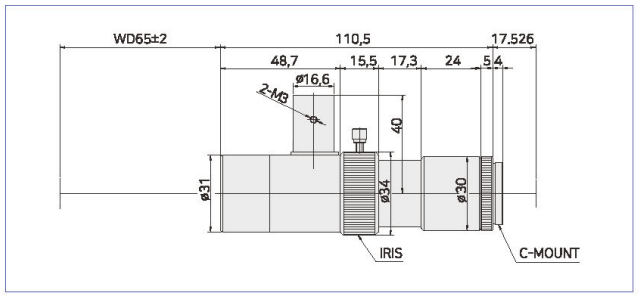
TCL 2.0X-65-5M

Standard & Precision Optics



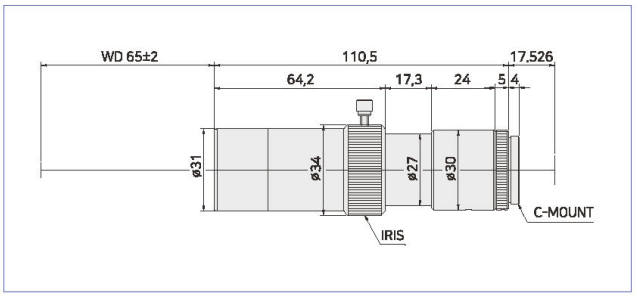
TCL 2.0X-65DI-5M

Standard & Precision Optics



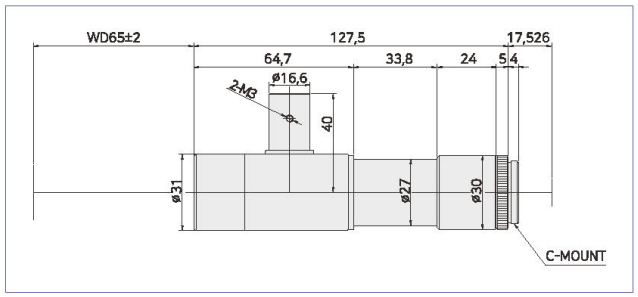
TCL 2.0X-65I-5M

Standard & Precision Optics



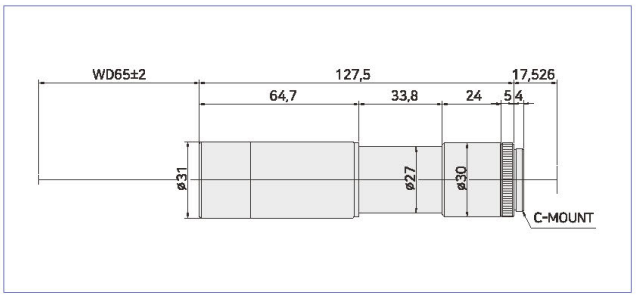
TCL 3.0X-65D-5M

Standard & Precision Optics



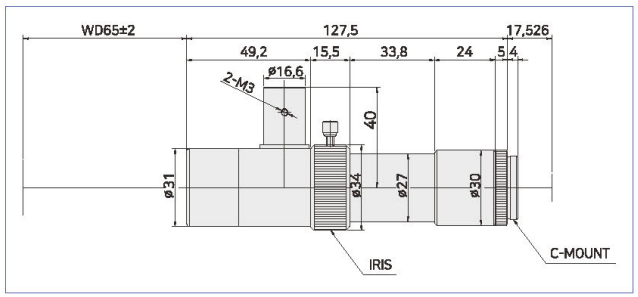
TCL 3.0X-65-5M

Standard & Precision Optics



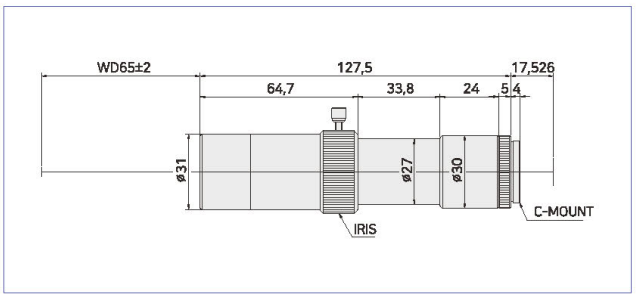
TCL 3.0X-65DI-5M

Standard & Precision Optics



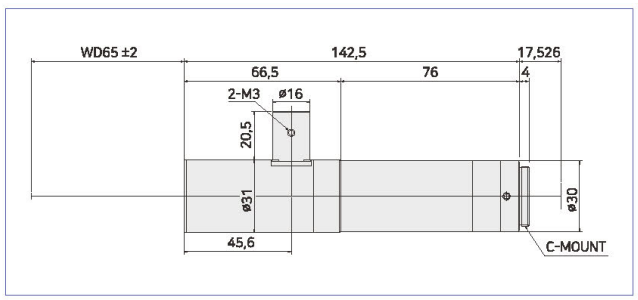
TCL 3.0X-65I-5M

Standard & Precision Optics



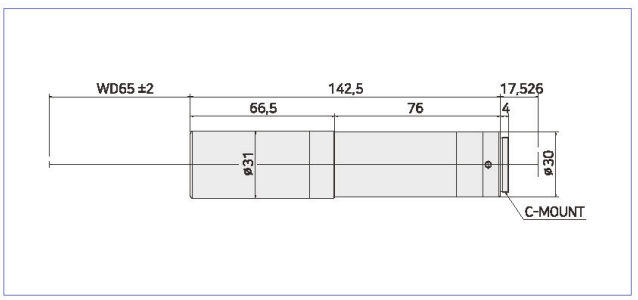
TCL 4.0X-65D-5M

Standard & Precision Optics



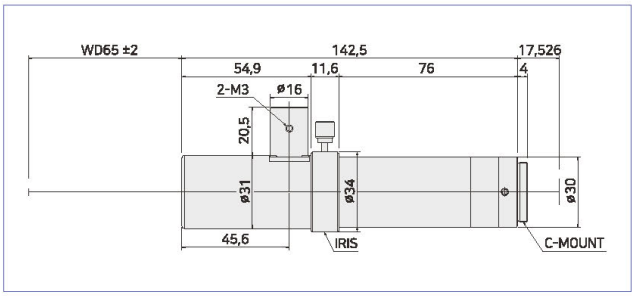
TCL 4.0X-65-5M

Standard & Precision Optics



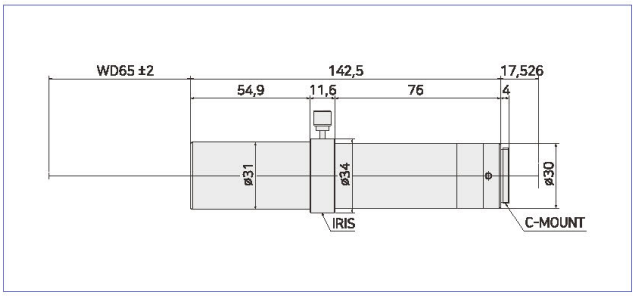
TCL 4.0X-65DI-5M

Standard & Precision Optics



TCL 4.0X-65I-5M

Standard & Precision Optics



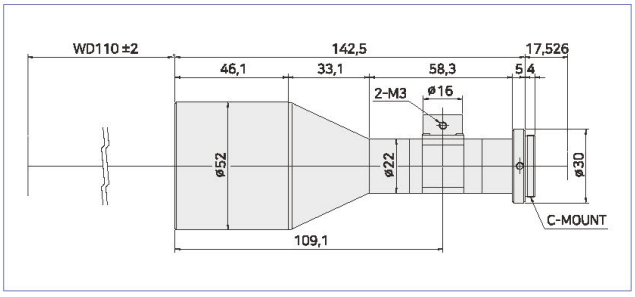
TCL-110-5M Series | W.D : 110㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≤degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.3X-110/D-5M	0.3X	110	15.3	0.0219	6.9	2.1㎜	0.04	0.02	2/3"(11㎜)	C
TCL 0.5X-110/D-5M	0.5X	110	7.2	0.0465	5.38	593	0.02	0.02	2/3"(11㎜)	C
TCL 0.5X-110/DI-5M										
TCL 0.7X-110/D-5M	0.7X	110	5.2	0.0651	5.38	303	0.02	0.02	2/3"(11㎜)	C
TCL 0.7X-110/DI-5M										
TCL 0.9X-110/D-5M	0.9X	110	4.5	0.075	6	204	0.025	0.01	2/3"(11㎜)	C
TCL 1.0X-110/D-5M	1.0X	110	4.4	0.077	6.5	179	0.03	0.03	2/3"(11㎜)	C
TCL 1.0X-110/DI-5M										
TCL 1.8X-110/D-5M	1.8X	110	4.1	0.081	11	93	0.03	0.03	2/3"(11㎜)	C
TCL 2.0X-110/D-5M	2.0X	110	3.7	0.09	11	75	0.05	0.03	2/3"(11㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 13.8㎛

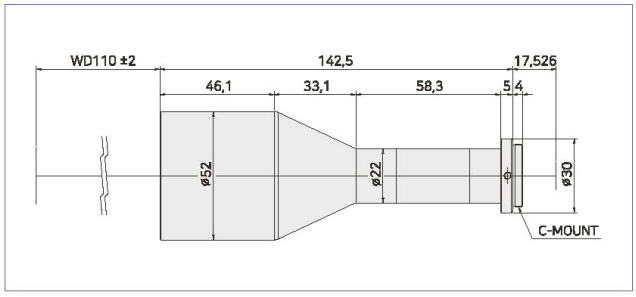
TCL 0.3X-110D-5M

Standard & Precision Optics



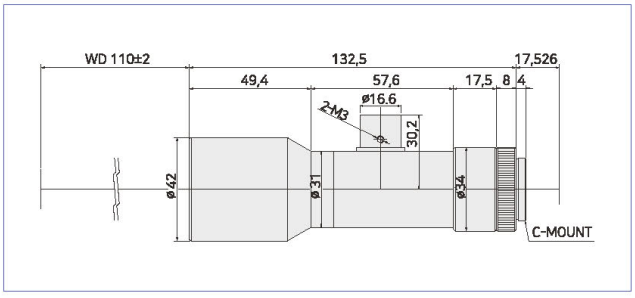
TCL 0.3X-110-5M

Standard & Precision Optics



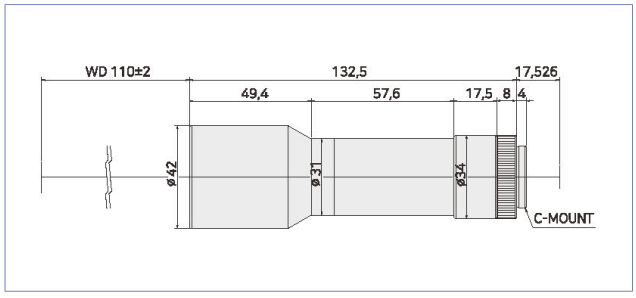
TCL 0.5X-110D-5M

Standard & Precision Optics



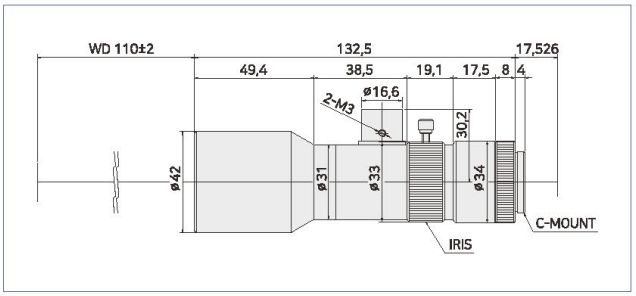
TCL 0.5X-110-5M

Standard & Precision Optics



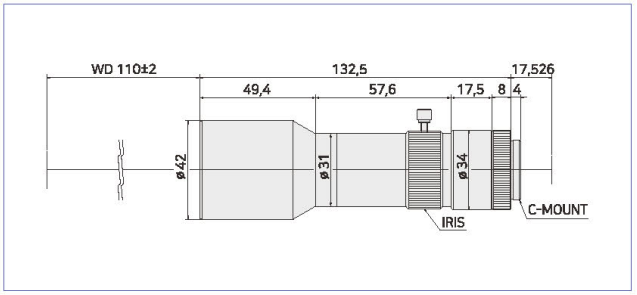
TCL 0.5X-110DI-5M

Standard & Precision Optics



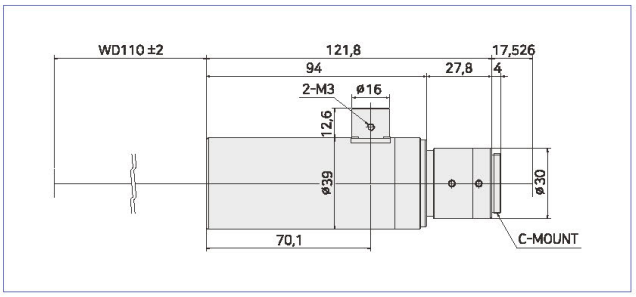
TCL 0.5X-110I-5M

Standard & Precision Optics



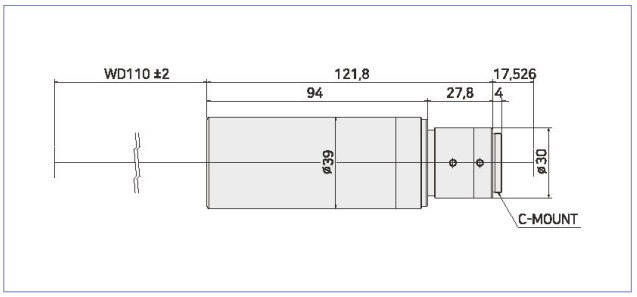
TCL 0.7X-110D-5M

Standard & Precision Optics



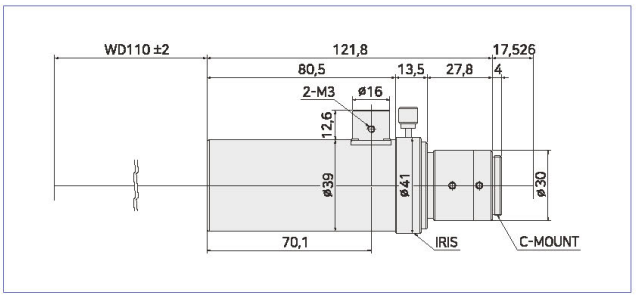
TCL 0.7X-110-5M

Standard & Precision Optics



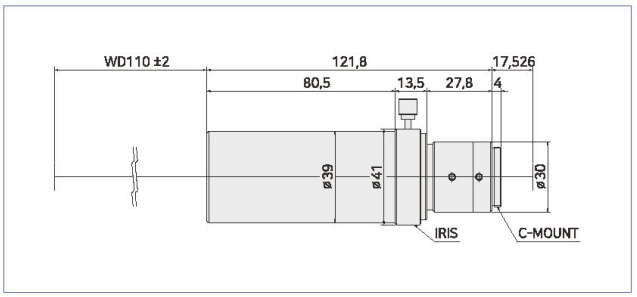
TCL 0.7X-110DI-5M

Standard & Precision Optics



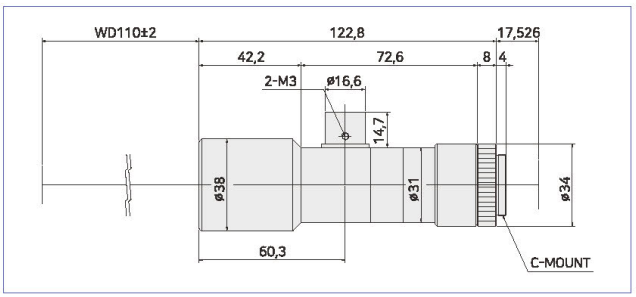
TCL 0.7X-110I-5M

Standard & Precision Optics



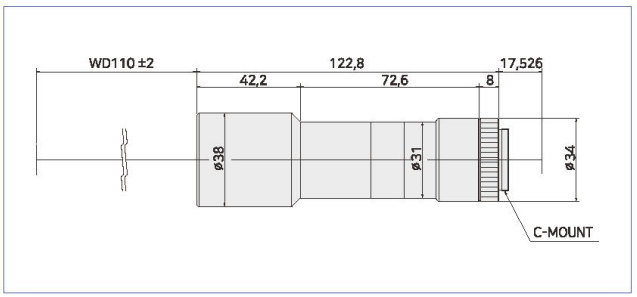
TCL 0.9X-110D-5M

Standard & Precision Optics



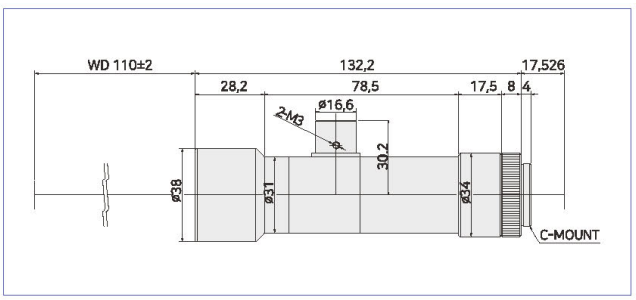
TCL 0.9X-110-5M

Standard & Precision Optics



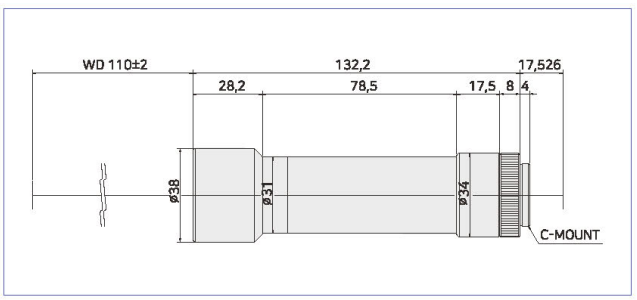
TCL 1.0X-110D-5M

Standard & Precision Optics



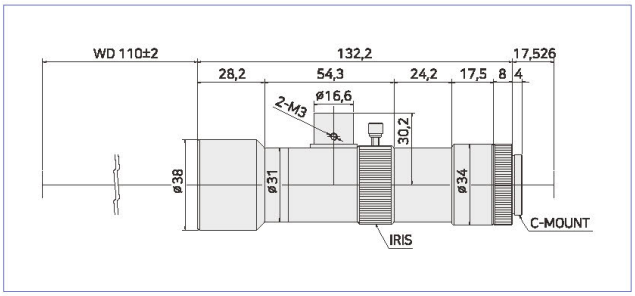
TCL 1.0X-110-5M

Standard & Precision Optics



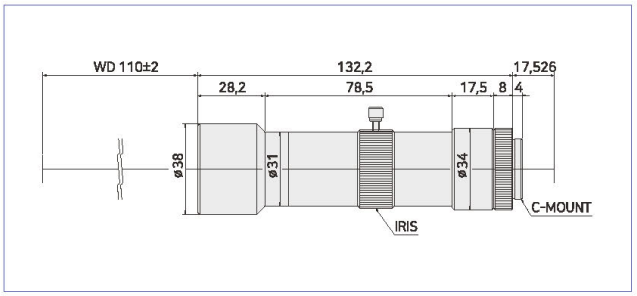
TCL 1.0X-110DI-5M

Standard & Precision Optics



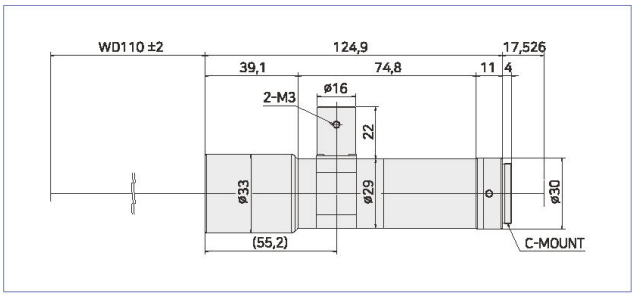
TCL 1.0X-110I-5M

Standard & Precision Optics



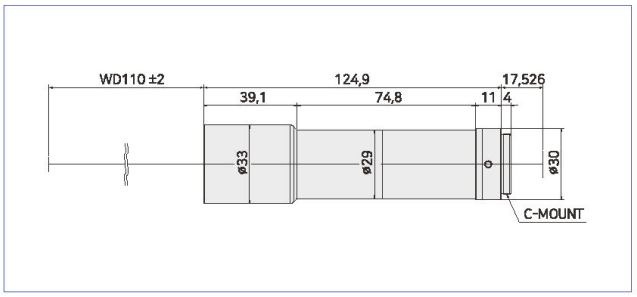
TCL 1.8X-110D-5M

Standard & Precision Optics



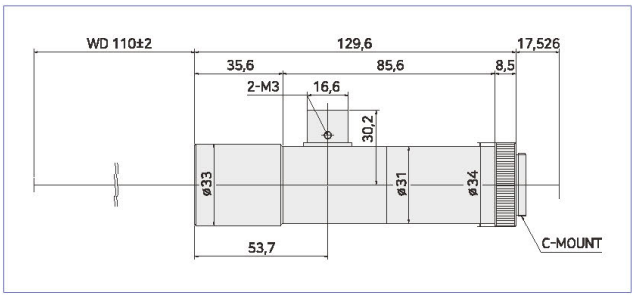
TCL 1.8X-110-5M

Standard & Precision Optics



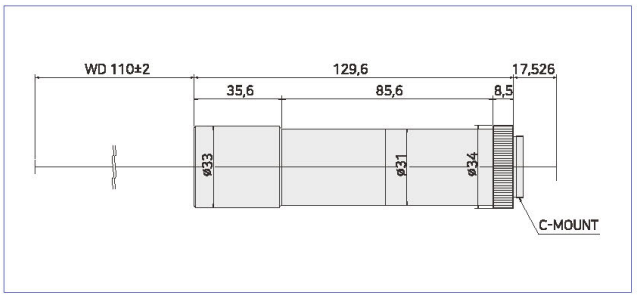
TCL 2.0X-110D-5M

Standard & Precision Optics



TCL 2.0X-110-5M

Standard & Precision Optics



Standard & Precision Optics

Pixel Resolution vs Optical Resolution

Commonly, we use 2 types of resolutions in the machine field. But there are somewhat confusion meaning of these resolutions. Follow pictures show the different meaning between pixel resolution and optical resolution.

Standard & Precision Optics Pixel Resolution

It means that area of one pixel to object also relate with magnification of lens.

Pixel resolution : 11.5 μm

Standard & Precision Optics Optical Resolution

It is the capacity to distinguish two adjacent points also express the lens real resolving power.
Optical resolution is determined by N.A and wavelength.

ex) Has to be seen separately for adjacent patterns or defects
When defect size is very small or the detection power is affected to lens performance.

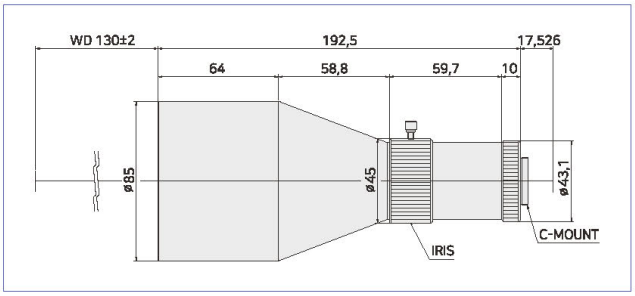
TCL-130-5M Series | W.D : 130㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (~degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.315X-130I-5M	0.315X	130	13.3	0.0252	6.25	1.7㎜	0.03	0.03	2/3"(11㎜)	C
TCL 0.348X-130I-5M	0.348X	130	12.1	0.0278	6.26	1.4㎜	0.03	0.04	2/3"(11㎜)	C
TCL 0.42X-132I-5M	0.42X	132	7.3	0.0462	4.5	704	0.03	0.03	2/3"(11㎜)	C
TCL 0.7X-130I-5M	0.7X	130	5.3	0.063	5.5	309	0.03	0.05	2/3"(11㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 13.8㎛

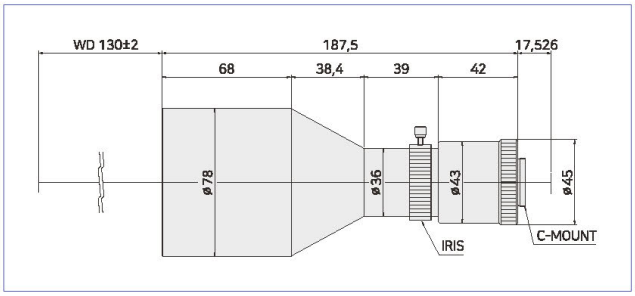
TCL 0.315X-130I-5M

Standard & Precision Optics



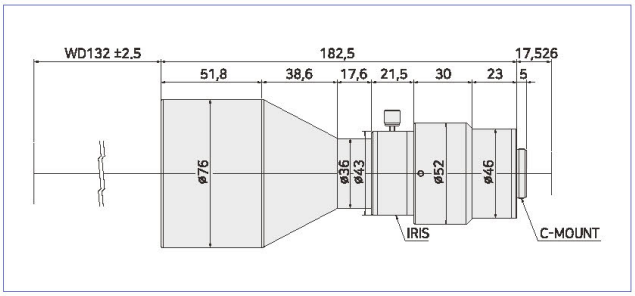
TCL 0.348X-130I-5M

Standard & Precision Optics



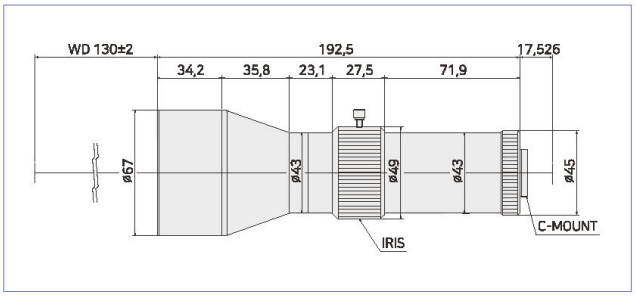
TCL 0.42X-132I-5M

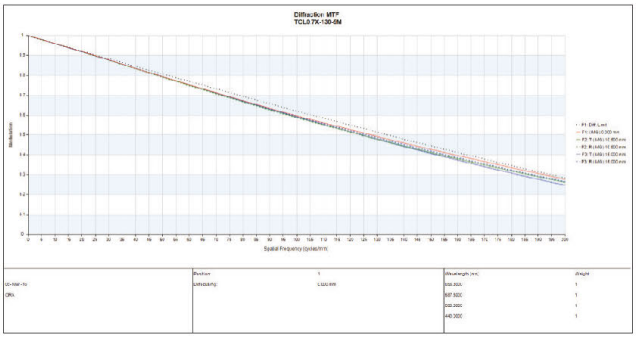
Standard & Precision Optics

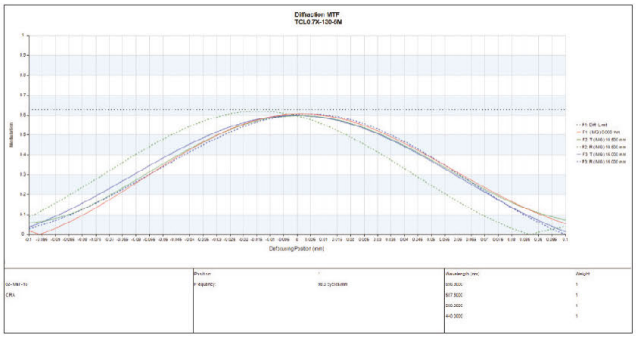


TCL 0.7X-130I-5M

Standard & Precision Optics







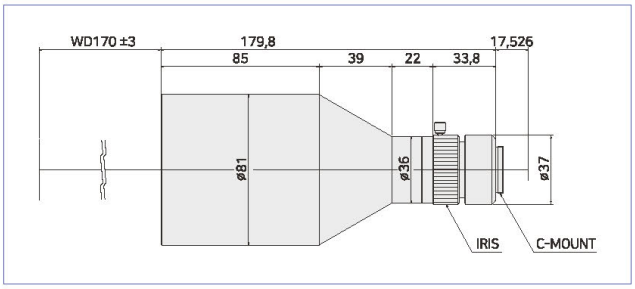
TCL-150 & 170-5M Series | W.D : 150 & 170㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≒degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.17X-170I-5M	0.17X	170	19.7	0.017	5	4.7㎜	0.03	0.06	2/3"(11㎜)	C
TCL 0.26X-150I-5M	0.26X	150	13.7	0.0245	5.3	2.1㎜	0.03	0.08	2/3"(11㎜)	C
TCL 0.3X-170I-5M	0.3X	170	17.9	0.0187	8	2.4㎜	0.03	0.01	2/3"(11㎜)	C
TCL 0.65X-170/D-5M	0.65X	170	5.8	0.058	5.6	365	0.02	0.06	2/3"(11㎜)	C
TCL 1.0X-150I-5M	1.0X	150	5.1	0.066	7.5	207	0.03	0.03	2/3"(11㎜)	C
TCL 1.5X-150/D-5M	1.5X	150	4.4	0.075	10	122	0.03	0.04	2/3"(11㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 13.8㎛

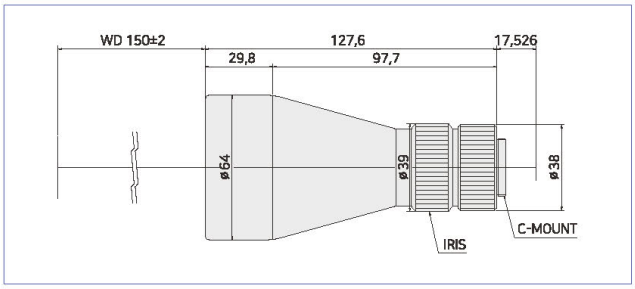
TCL 0.17X-170I-5M

Standard & Precision Optics



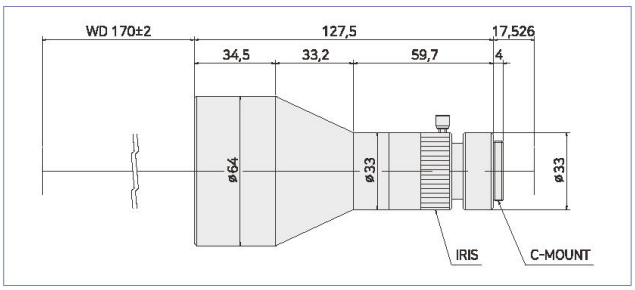
TCL 0.26X-150I-5M

Standard & Precision Optics



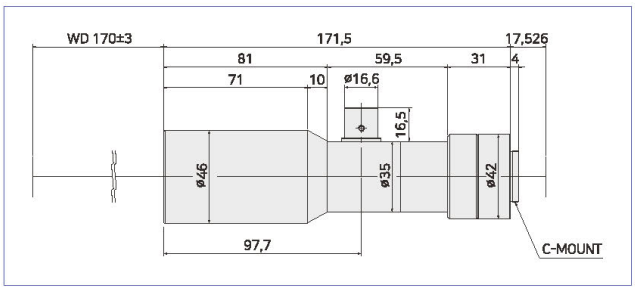
TCL 0.3X-170I-5M

Standard & Precision Optics



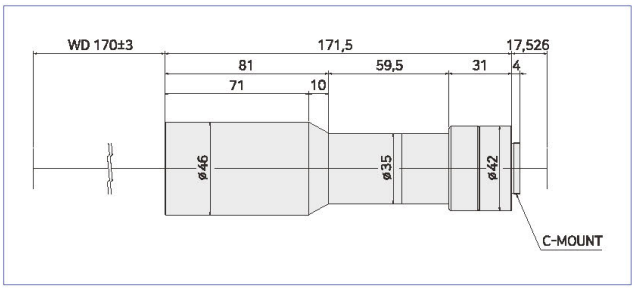
TCL 0.65X-170D-5M

Standard & Precision Optics



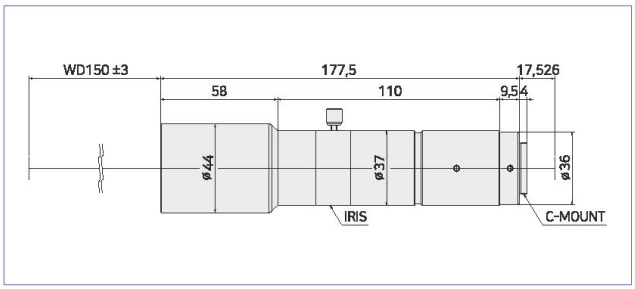
TCL 0.65X-170-5M

Standard & Precision Optics



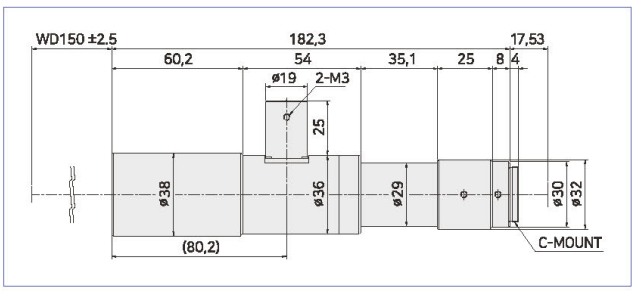
TCL 1.0X-150I-5M

Standard & Precision Optics



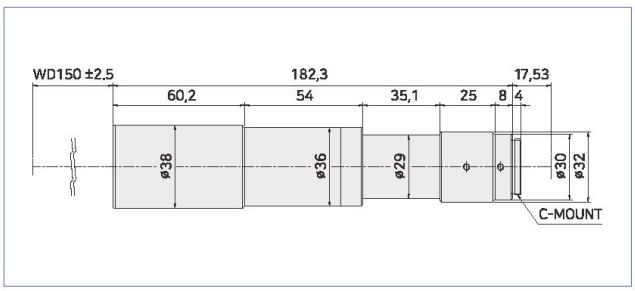
TCL 1.5X-150D-5M

Standard & Precision Optics



TCL 1.5X-150-5M

Standard & Precision Optics



TCL-UHR Series

FEATURES

- Designed to support for the small pixel size camera (1.67㎛/pixel).
- Can support up to 2/3" (11㎜ diagonal length).
- Low F/# and high contrast & resolution design.
- Iris diaphragm is adapted for adjusting the D.O.F.

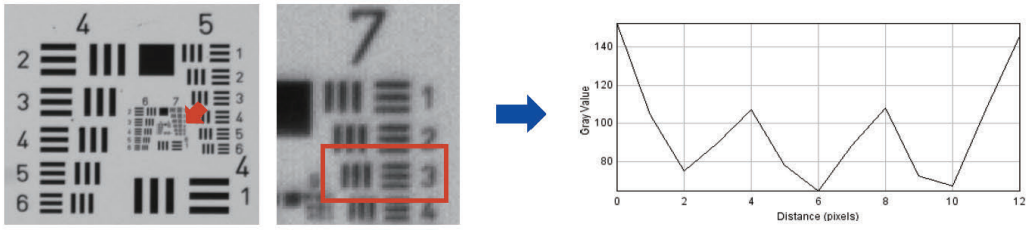
There is an inquiry for the small pixel size camera which is required for precision and high accuracy in the machine applications. Thus, lens quality also have to be maintained to support the small pixel size camera.

SPO designed the UHR lenses to support for the small pixel size camera. UHR lenses are good for precise and accurate measurement by performing the more high contrast and resolution than standard HR lenses. Customer can get the high-quality and contrast images by adaption small size pixel camera and uniform coaxial illumination over the whole F.O.V.

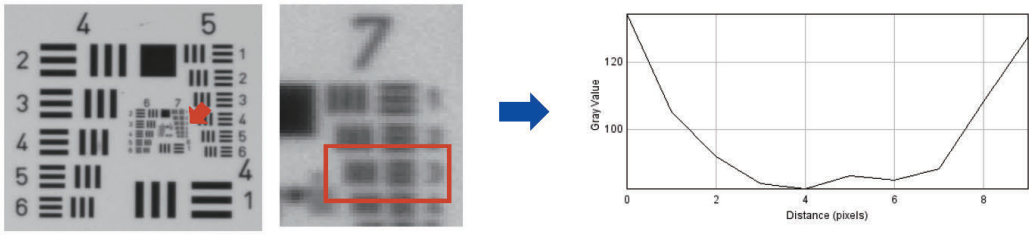
Standard & Precision Optics

Comparison for image contrast | TCL 1.0X-65/DI-UHR VS TCL 1.0X-65/D-HR

UHR Series Lens



HR Series Lens



TCL-UHR Series have very low F/# and High N.A where High contrast and High quality image.

SPO have various UHR lens according to magnification and W.D.
Please, Ask to us for more special lens if you need. SPO will provide the best solution for various applications.

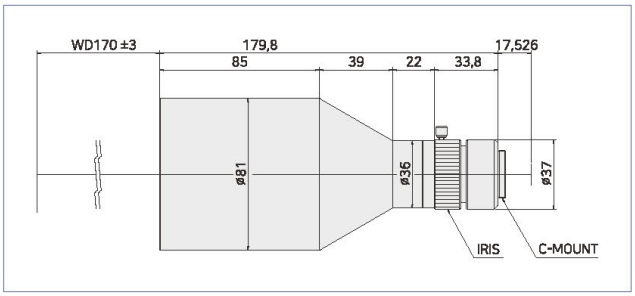
TCL-UHR Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (-=degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.17X-170I-UHR	0.17X	170	20	0.017	5	3㎜	0.03	0.03	2/3"(11㎜)	C
TCL 0.42X-132I-UHR	0.42X	132	7.3	0.0462	4.5	448	0.02	0.04	2/3"(11㎜)	C
TCL 0.5X-65/DI-UHR	0.5X	65	6	0.0555	4.5	316	0.04	0.03	2/3"(11㎜)	C
TCL 1.0X-65/DI-UHR	1.0X	65	3	0.11	4.5	79	0.04	0.03	2/3"(11㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 8.8㎛

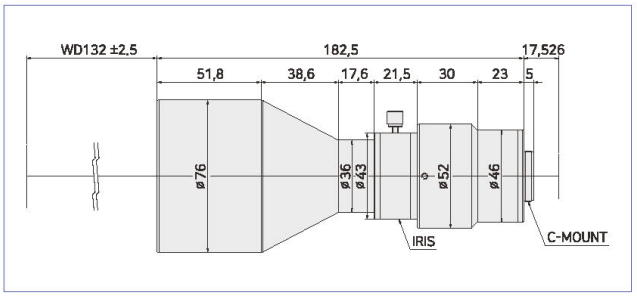
TCL 0.17X-170I-UHR

Standard & Precision Optics



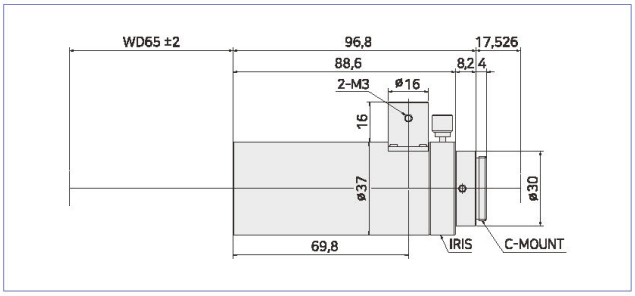
TCL 0.42X-132I-UHR

Standard & Precision Optics



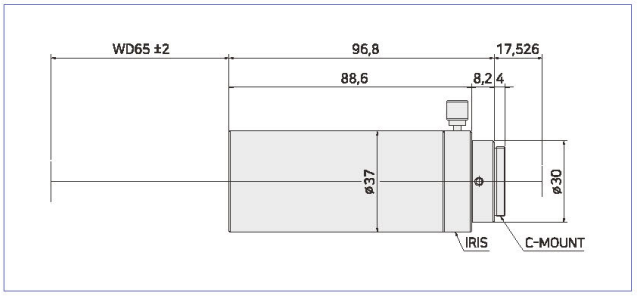
TCL 0.5X-65DI-UHR

Standard & Precision Optics



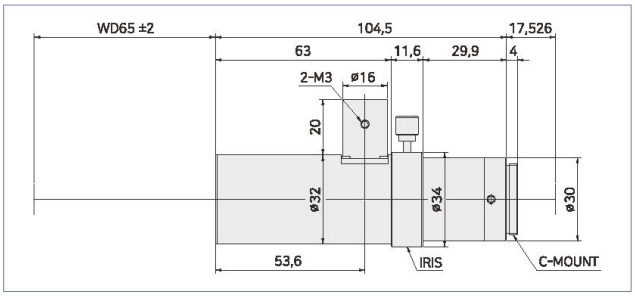
TCL 0.5X-65I-UHR

Standard & Precision Optics



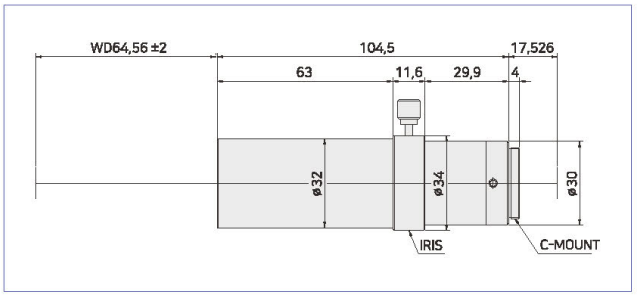
TCL 1.0X-65DI-UHR

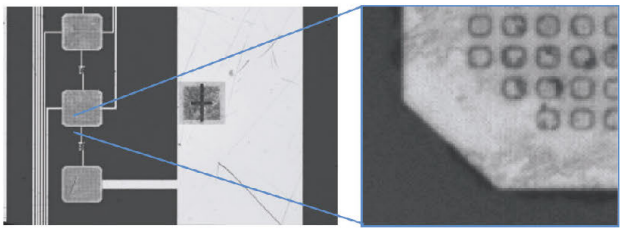
Standard & Precision Optics



TCL 1.0X-65I-UHR

Standard & Precision Optics





TCL-HR Series

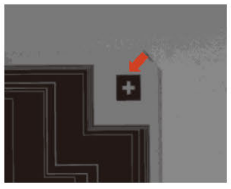
FEATURES

- Designed for mega pixel camera that is 4.65㎛/pixel.
- Good uniformed coaxial illumination for the F.O.V. by eliminating of the hot spot.
- Will show the real imaging power in high-end inspection and alignment applications.
- SPO have lined up according to W.D and magnification which can support up to 2/3" camera.

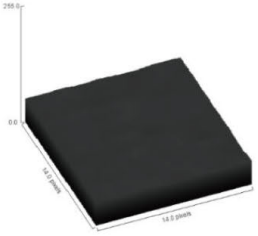
There are various magnifications and working distance with low distortion design and high resolution & contrast over the full F.O.V.

Standard & Precision Optics

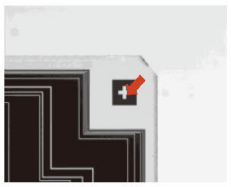
HR vs ST brightness comparison according to F/#



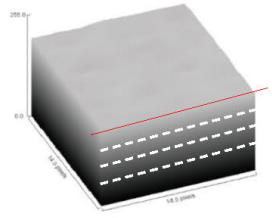
TCL 1.0X-113/D-ST(F/20.8)



Brightness is dark



TCL 1.0X-110/D-HR(F/10)



Brightness is 4X brighter

F/# 2X different
Brightness 4X different

Standard & Precision Optics

Relationship for according to the each factor

F/#	D.O.F	N.A	Resolution	Brightness
High	Increasing	Low	Low	Low
Low	Decreasing	High	High	High

F/# is related to the theoretical resolution and D.O.F & N.A of the lens directly.
Thus it have to be keep the optical theory (See the glossary).

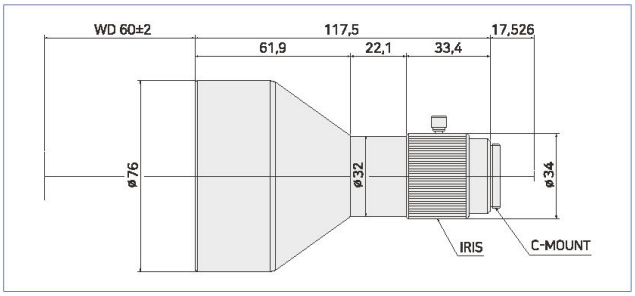
TCL-65-HR Series | W.D : 65㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (∝degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.13X-60I-HR-8	0.13X	60	34.6	0.0097	6.7	15.8㎜	0.03	0.08	1/2"(8㎜)	C
TCL 0.5X-65/D-HR	0.5X	65	11.2	0.03	8.3	1.3㎜	0.04	0.03	2/3"(11㎜)	C
TCL 0.8X-65/D-HR	0.8X	65	6.7	0.05	8	500	0.02	0.134	2/3"(11㎜)	C
TCL 1.0X-65/D-HR	1.0X	65	6.7	0.05	10	400	0.022	0.16	2/3"(11㎜)	C
TCL 1.5X-65/D-HR-8	1.5X	65	4.8	0.07	10.7	190	0.022	0.07	1/2"(8㎜)	C
TCL 2.0X-65/D-HR	2.0X	65	4.5	0.074	13.5	135	0.05	0.03	2/3"(11㎜)	C
TCL 2.4X-65/D-HR	2.4X	63.6	4.8	0.07	17.1	118	0.015	0.1	2/3"(11㎜)	C
TCL 3.0X-65/D-HR-8	3.0X	65	4	0.083	18	80	0.02	0.14	1/2"(8㎜)	C
TCL 4.0X-65/D-HR	4.0X	65	3	0.11	18.1	45	0.05	0.03	2/3"(11㎜)	C
TCL 6.0X-65/D-HR	6.0X	65	3	0.11	27.2	30	0.05	0.03	2/3"(11㎜)	C
TCL 10.0X-65/D-HR-8	10.0X	65	2.2	0.15	33.3	13	0.01	0.14	1/2"(8㎜)	C
TCL 12.0X-65/D-HR-8	12.0X	65	2.1	0.161	37.3	10	0.004	0.1	1/2"(8㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

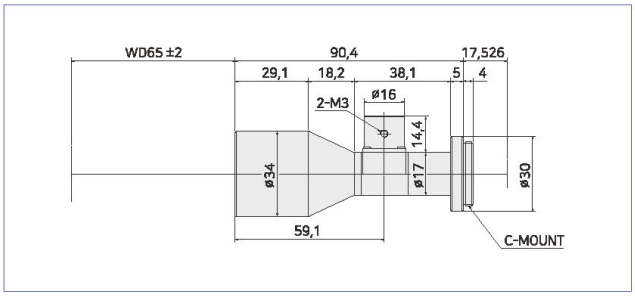
TCL 0.13X-60I-HR-8

Standard & Precision Optics



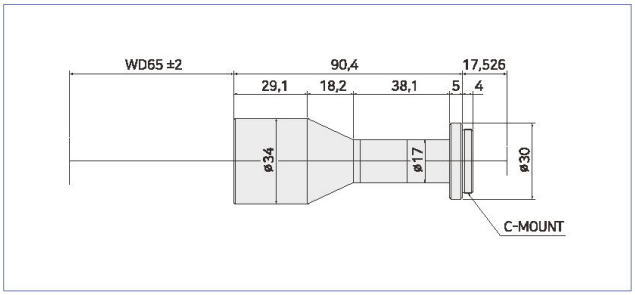
TCL 0.5X-65D-HR

Standard & Precision Optics



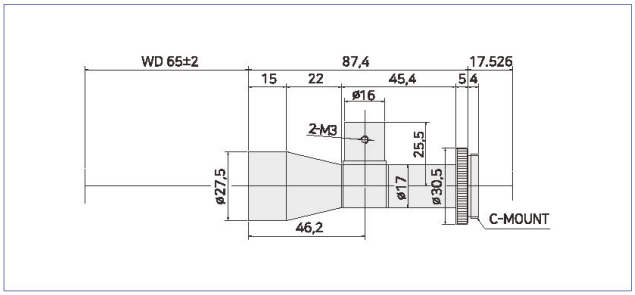
TCL 0.5X-65-HR

Standard & Precision Optics



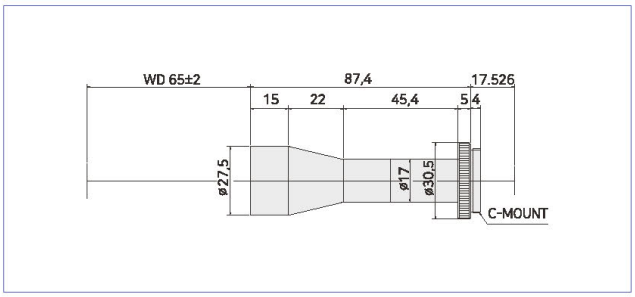
TCL 0.8X-65D-HR

Standard & Precision Optics



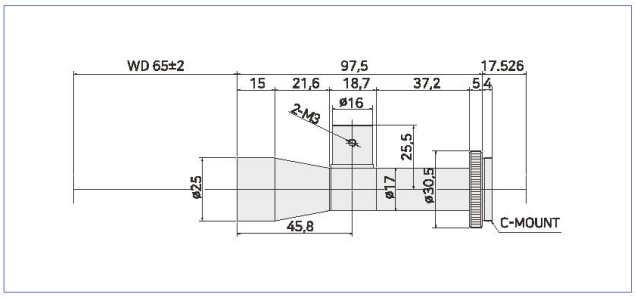
TCL 0.8X-65-HR

Standard & Precision Optics



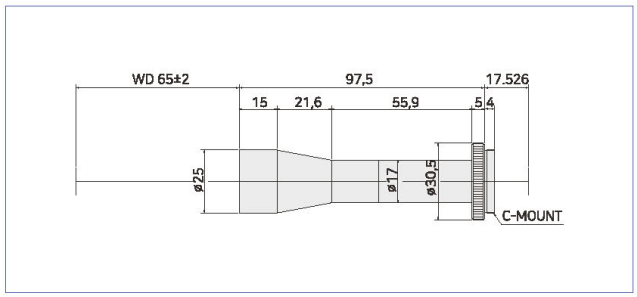
TCL 1.0X-65D-HR

Standard & Precision Optics



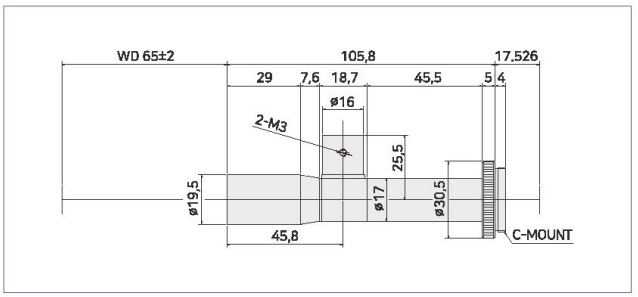
TCL 1.0X-65-HR

Standard & Precision Optics



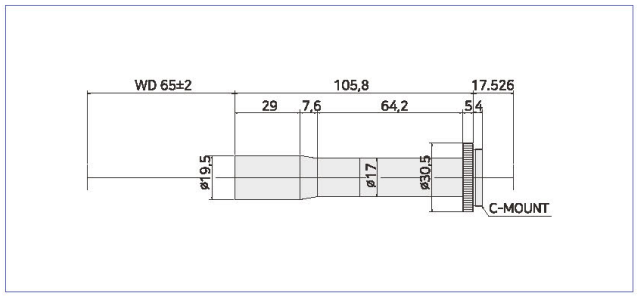
TCL 1.5X-65D-HR-8

Standard & Precision Optics



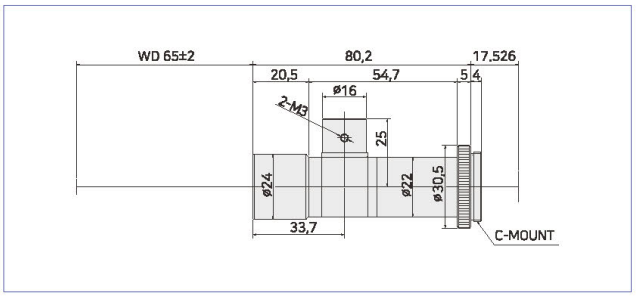
TCL 1.5X-65-HR-8

Standard & Precision Optics



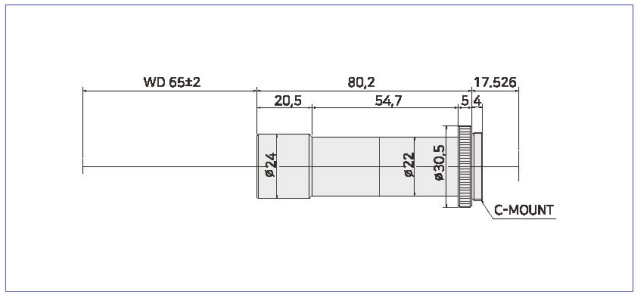
TCL 2.0X-65D-HR

Standard & Precision Optics



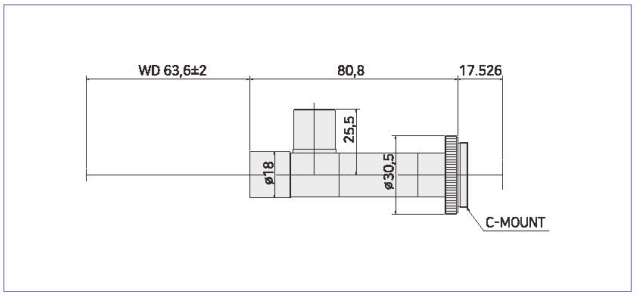
TCL 2.0X-65-HR

Standard & Precision Optics



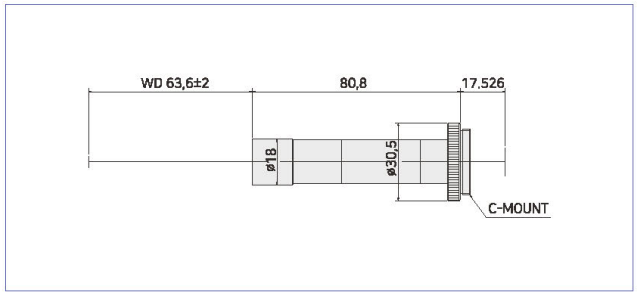
TCL 2.4X-65D-HR

Standard & Precision Optics



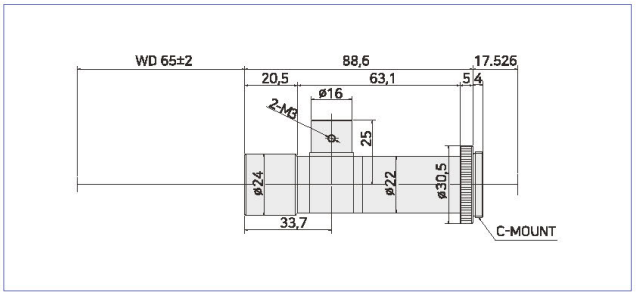
TCL 2.4X-65-HR

Standard & Precision Optics



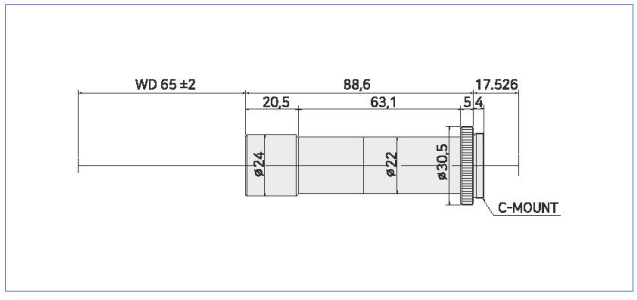
TCL 3.0X-65D-HR-8

Standard & Precision Optics



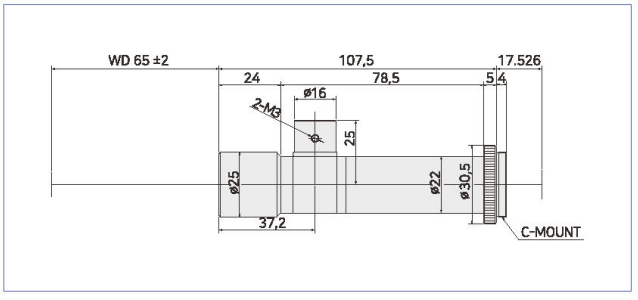
TCL 3.0X-65-HR-8

Standard & Precision Optics



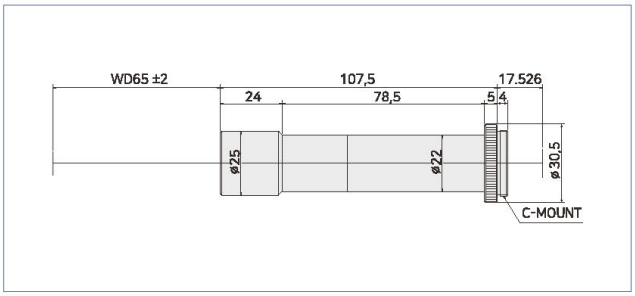
TCL 4.0X-65D-HR

Standard & Precision Optics



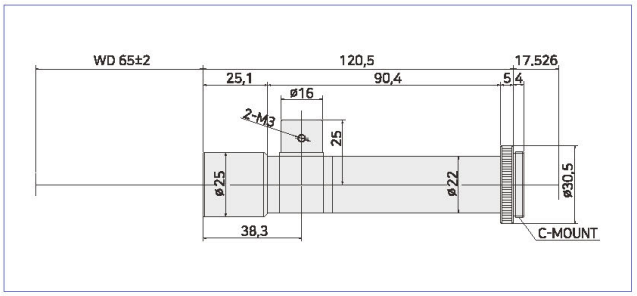
TCL 4.0X-65-HR

Standard & Precision Optics



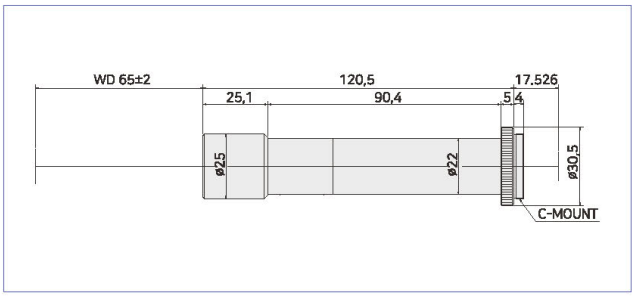
TCL 6.0X-65D-HR

Standard & Precision Optics



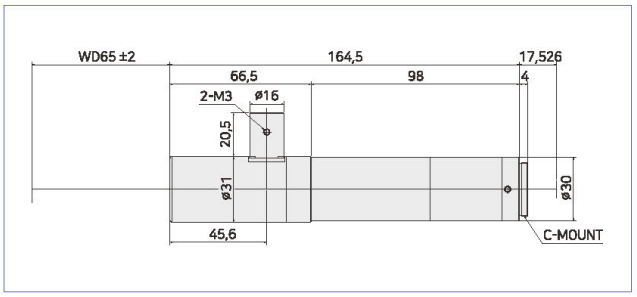
TCL 6.0X-65-HR

Standard & Precision Optics



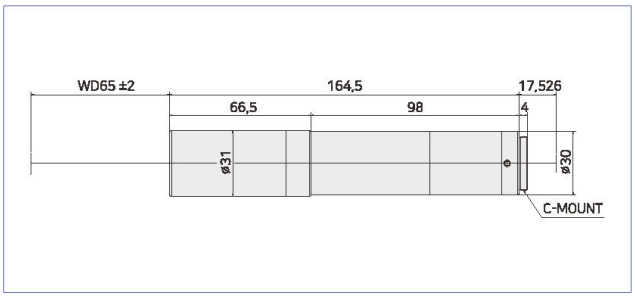
TCL 10.0X-65D-HR-8

Standard & Precision Optics



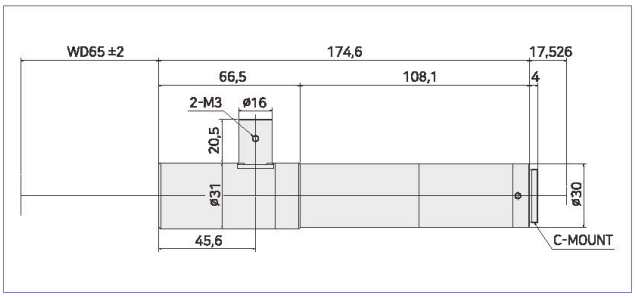
TCL 10.0X-65-HR-8

Standard & Precision Optics



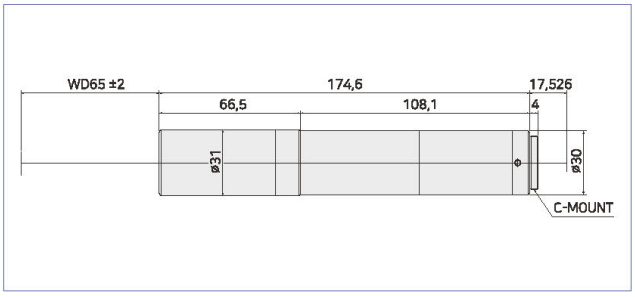
TCL 12.0X-65D-HR-8

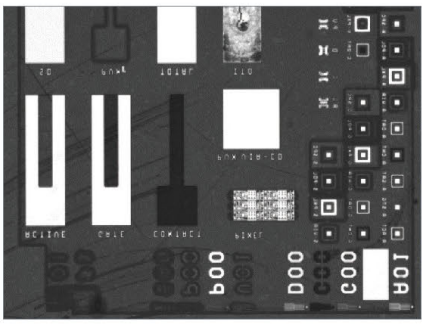
Standard & Precision Optics

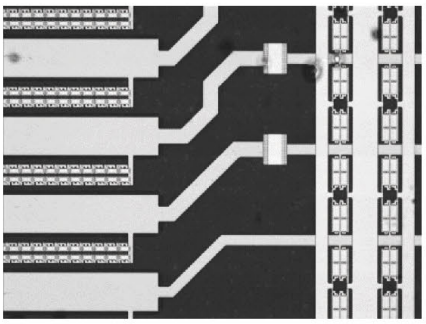


TCL 12.0X-65-HR-8

Standard & Precision Optics







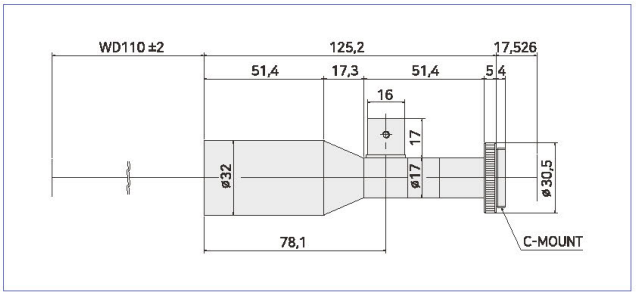
TCL-110-HR Series | W.D : 110㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≃degree)	Optical Distortion (%)	Sensor size	Mount
TCL0.35X-110/D-HR-8	0.35X	110	21.1	0.0159	11	3.5㎜	0.03	0.05	1/2"(8㎜)	C
TCL 0.5X-110/D-HR-6	0.5X	110	11.2	0.03	8.3	1.3㎜	0.03	0.02	1/3"(6㎜)	C
TCL 0.5X-110/D-HR	0.5X	110	14.9	0.0225	11.1	1.7㎜	0.03	0.03	2/3"(11㎜)	C
TCL 0.8X-110/D-HR	0.8X	110	11.2	0.03	13.3	831	0.017	0.15	2/3"(11㎜)	C
TCL 1.0X-110/D-HR	1.0X	110	6.7	0.05	10	400	0.03	0.15	2/3"(11㎜)	C
TCL 1.5X-110/D-HR	1.5X	110	7	0.048	15.6	277	0.01	0.15	2/3"(11㎜)	C
TCL 1.5X-110/D-HR-8	1.5X	110	5.6	0.06	12.5	222	0.02	0.06	1/2"(8㎜)	C
TCL 2.0X-110/D-HR	2.0X	110	4.4	0.077	13	130	0.02	0.03	2/3"(11㎜)	C
TCL 3.0X-110/D-HR-8	3.0X	110	3.7	0.09	16.6	73	0.02	0.11	1/2"(8㎜)	C
TCL 4.0X-110/D-HR	4.0X	110	3.7	0.09	22.2	55	0.05	0.03	2/3"(11㎜)	C
TCL 6.0X-110/D-HR	6.0X	110	3.7	0.09	33.3	37	0.05	0.03	2/3"(11㎜)	C
TCL 8.0X-110/D-HR	8.0X	110	3.7	0.09	44.4	27	0.05	0.19	2/3"(11㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

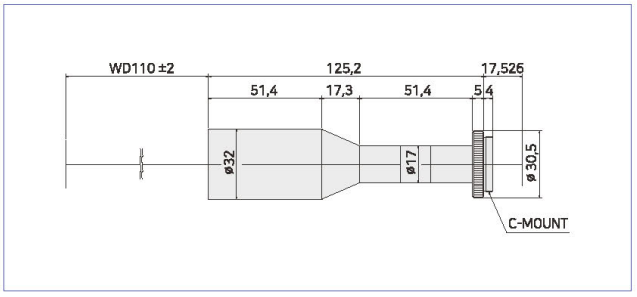
TCL 0.35X-110D-HR-8

Standard & Precision Optics



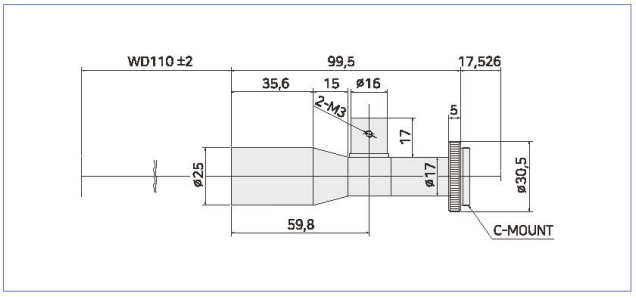
TCL 0.35X-110-HR-8

Standard & Precision Optics



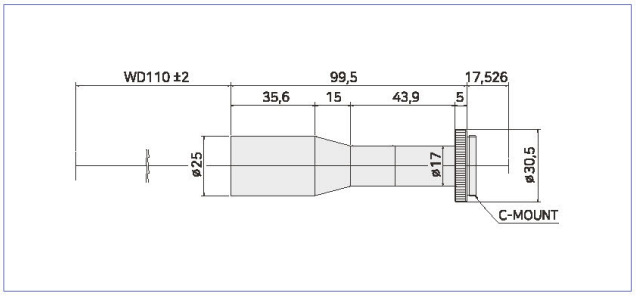
TCL 0.5X-110D-HR-6

Standard & Precision Optics



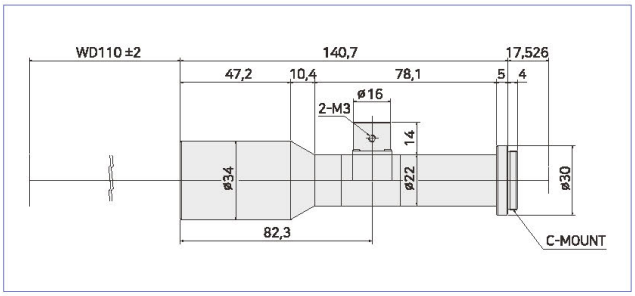
TCL 0.5X-110-HR-6

Standard & Precision Optics



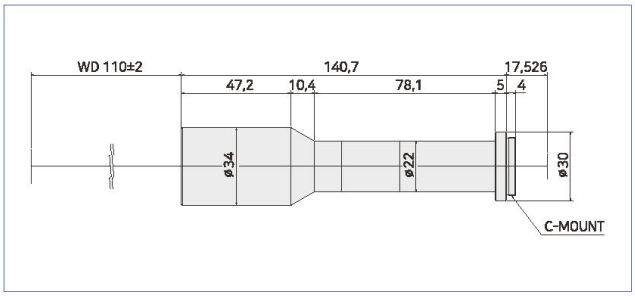
TCL 0.5X-110D-HR

Standard & Precision Optics



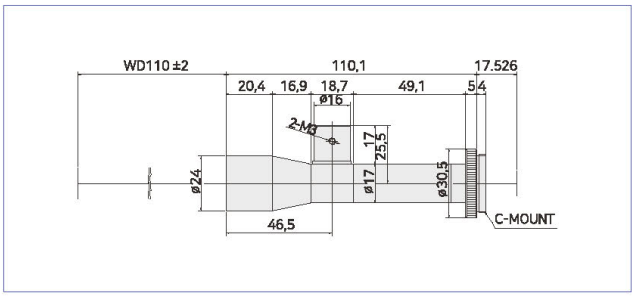
TCL 0.5X-110-HR

Standard & Precision Optics



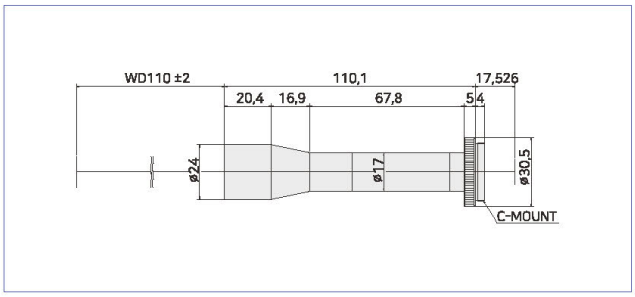
TCL 0.8X-110D-HR

Standard & Precision Optics



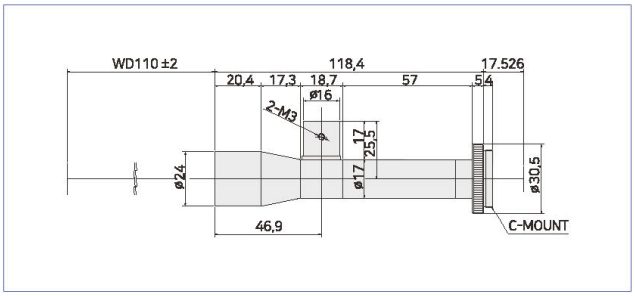
TCL 0.8X-110-HR

Standard & Precision Optics



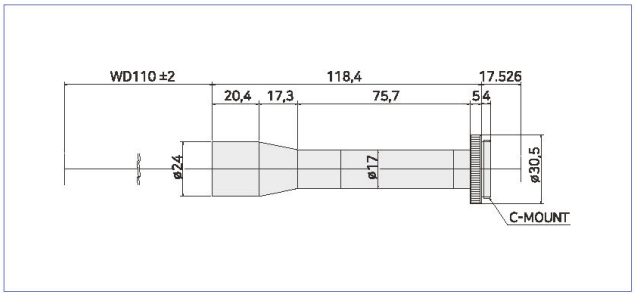
TCL 1.0X-110D-HR

Standard & Precision Optics



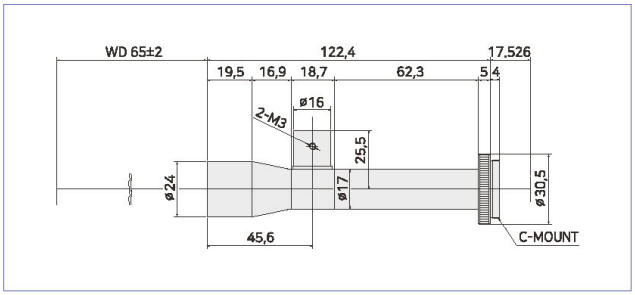
TCL 1.0X-110-HR

Standard & Precision Optics



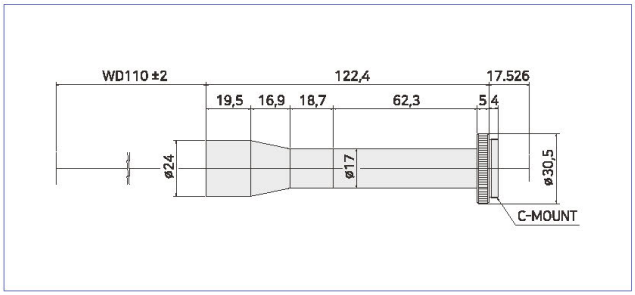
TCL 1.5X-110D-HR

Standard & Precision Optics



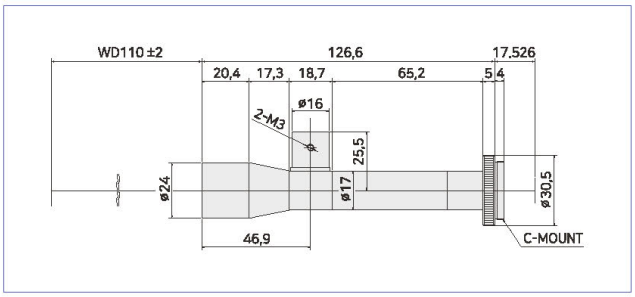
TCL 1.5X-110-HR

Standard & Precision Optics



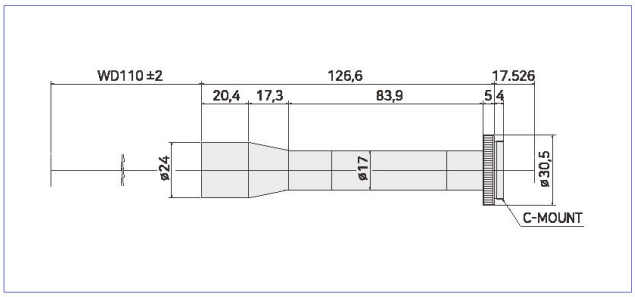
TCL 1.5X-110D-HR-8

Standard & Precision Optics



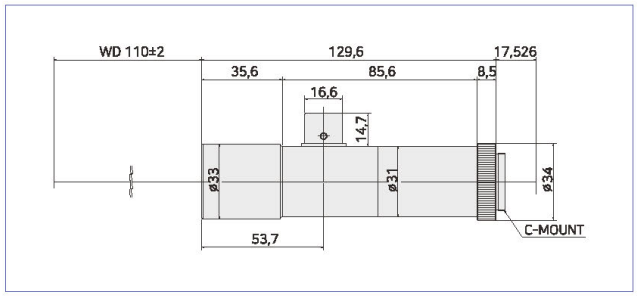
TCL 1.5X-110-HR-8

Standard & Precision Optics



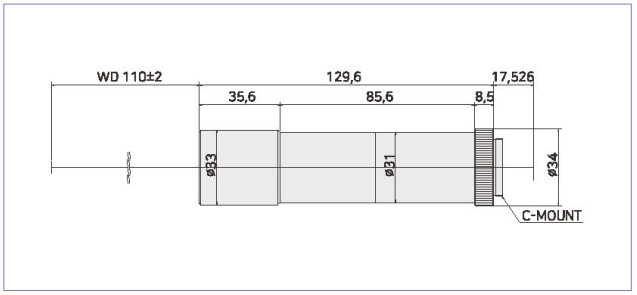
TCL 2.0X-110D-HR

Standard & Precision Optics



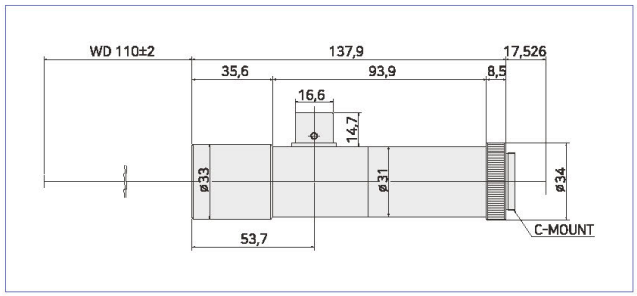
TCL 2.0X-110-HR

Standard & Precision Optics



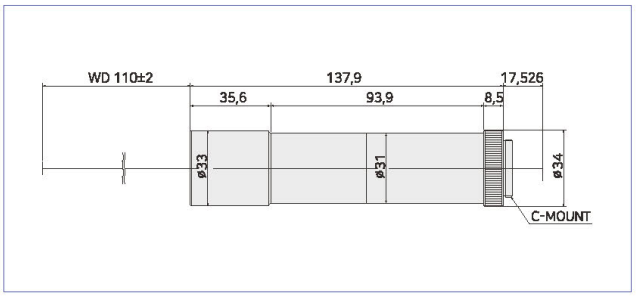
TCL 3.0X-110D-HR-8

Standard & Precision Optics



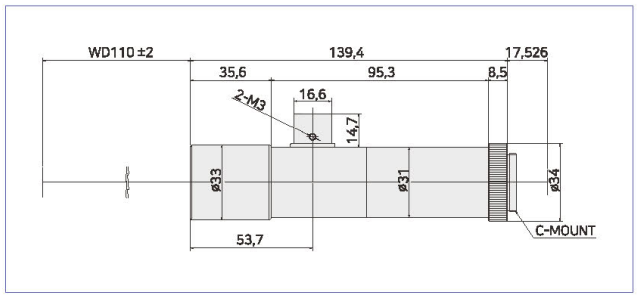
TCL 3.0X-110-HR-8

Standard & Precision Optics



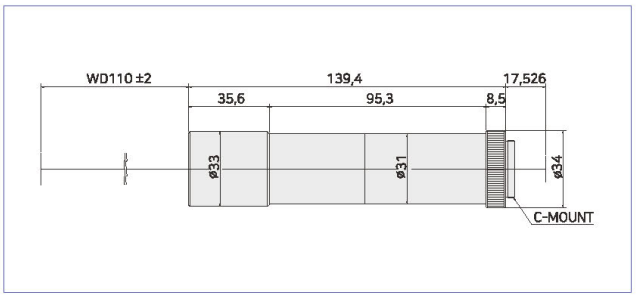
TCL 4.0X-110D-HR

Standard & Precision Optics



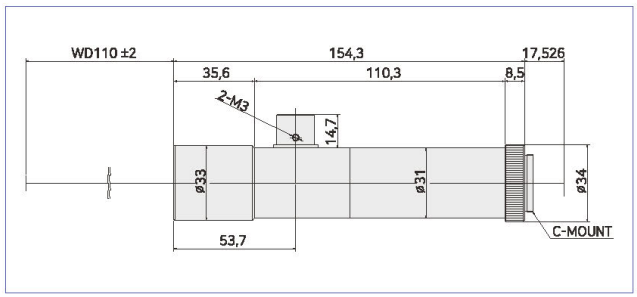
TCL 4.0X-110-HR

Standard & Precision Optics



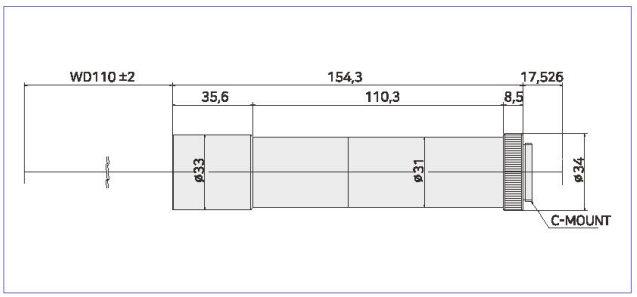
TCL 6.0X-110D-HR

Standard & Precision Optics



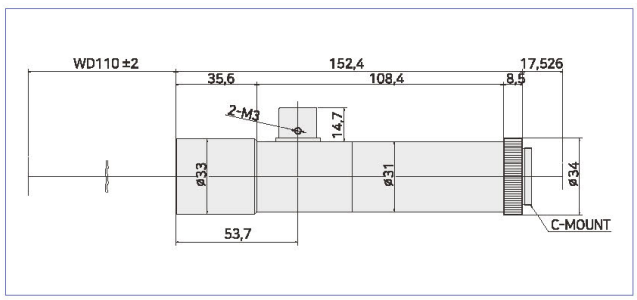
TCL 6.0X-110-HR

Standard & Precision Optics



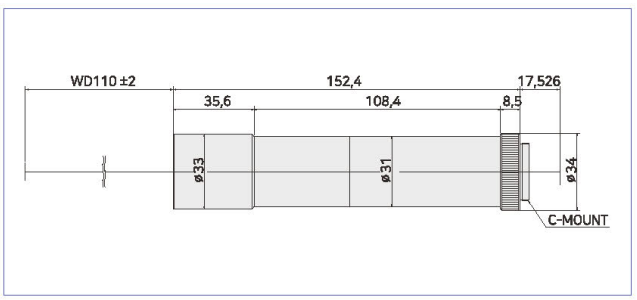
TCL 8.0X-110D-HR

Standard & Precision Optics



TCL 8.0X-110-HR

Standard & Precision Optics



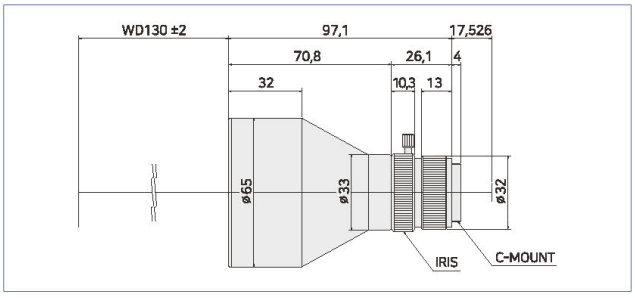
TCL-130 & 170-HR Series | W.D : 130 & 170㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Telecentricity (∝degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.165X-130I-HR-8	0.165X	130	28	0.012	6.8	9.9	0.017	0.15	1/2"(8㎜)	C
TCL 0.23X-130I-HR	0.23X	130	21	0.016	7.2	5.4	0.01	0.13	2/3"(11㎜)	C
TCL 0.3X-130I-HR	0.3X	130	17.7	0.019	7.9	3.5	0.04	0.08	2/3"(11㎜)	C
TCL 0.35X-130I-HR	0.35X	130	14	0.0238	7.3	2.3	0.035	0.08	1/2"(8㎜)	C
TCL 0.5X-170/DI-HR	0.5X	170	16	0.022	11.3	1.8	0.04	0.03	2/3"(11㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

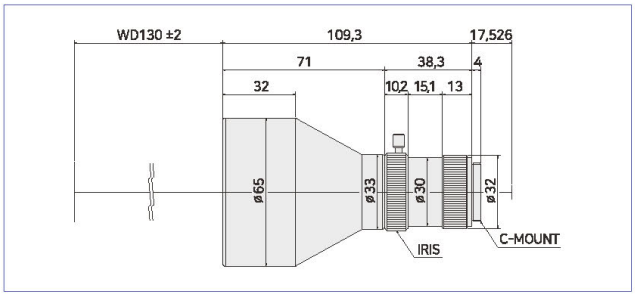
TCL 0.165X-130I-HR-8

Standard & Precision Optics



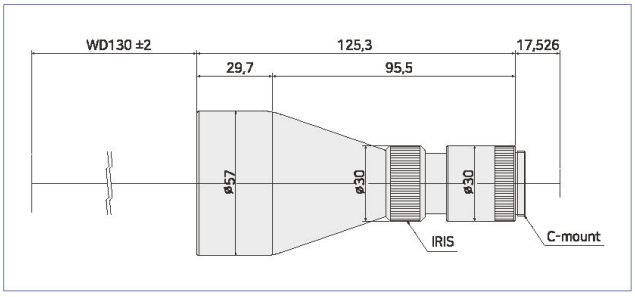
TCL 0.23X-130I-HR

Standard & Precision Optics



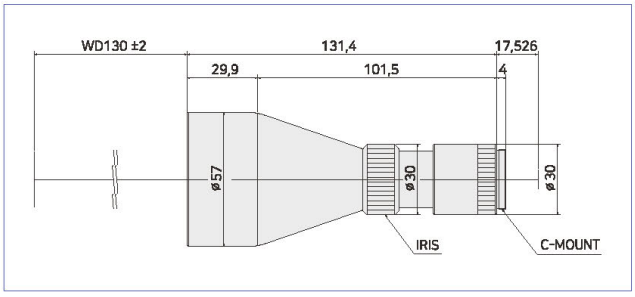
TCL 0.3X-130I-HR

Standard & Precision Optics



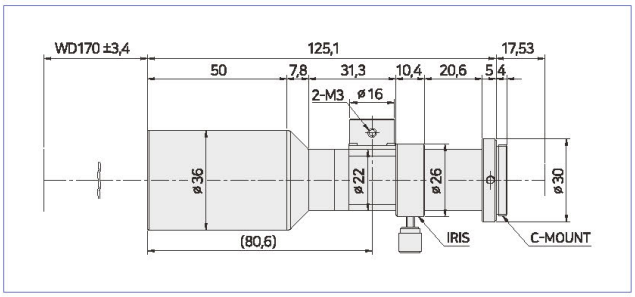
TCL 0.35X-130I-HR

Standard & Precision Optics



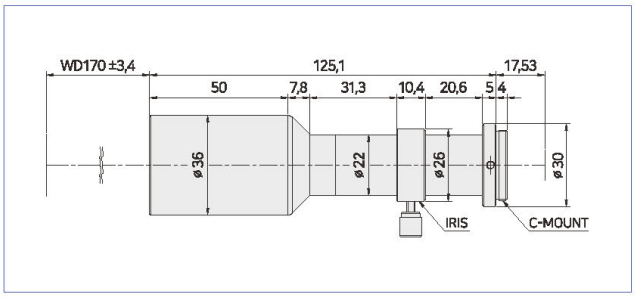
TCL 0.5X-170DI-HR

Standard & Precision Optics



TCL 0.5X-170I-HR

Standard & Precision Optics



TCL-ST Series

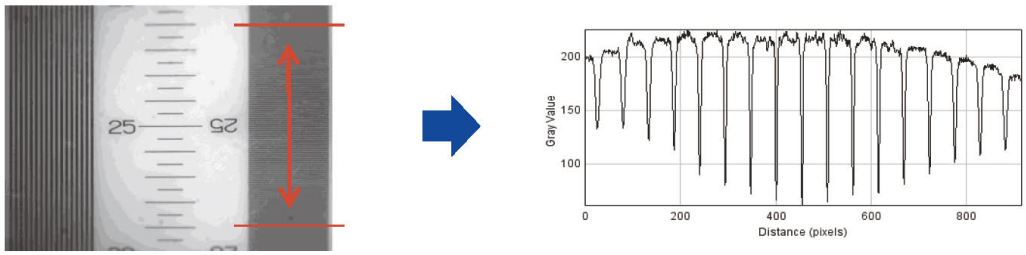
FEATURES

- Various types of telecentric lenses like different working distance, magnification, CCD size & high resolution.
- It is fixed magnification lens with even coaxial illumination type.
- Compact design with same lens barrel of most lenses for easy to installation.
- It is highly recommended the alignment & surface inspection applications.
- Support up to Max. 8㎜ diagonal length (1/2" camera).

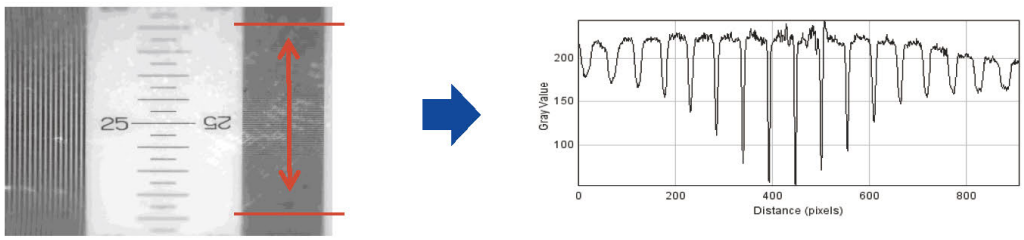
Standard & Precision Optics

Comparison for ST Series vs HR Series D.O.F.

TCL 0.5X-65/D-ST



TCL 0.5X-65/D-HR



If you want get longer D.O.F which is higher F/#, we recommend "ST Series".
Also when you choose ½" format camera, you had better to use "ST Series" to save the cost.
SPO will give the best solution after comparing the specification for lens and camera and then you can save the cost and time to make a system. Please, ask to us.

TIP

Standard & Precision Optics

I wish I could purchase 2X

Use to 2.0X Extender Lens for changing magnification.
Just adapt to C-mount W.D no change Mag. 2.0X up!!

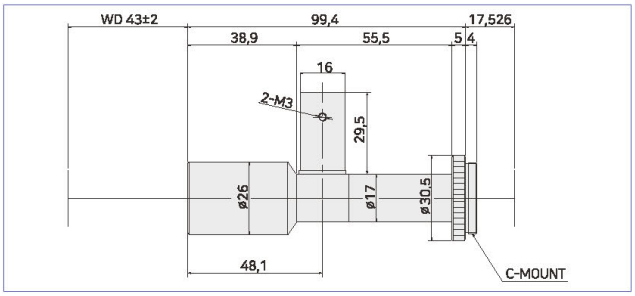
TCL-40-ST Series | W.D : 40㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (~< degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.5X-40/D-ST	0.5X	43	11.2	0.03	8.3	1.3㎜	0.03	0.08	1/2"(8㎜)	C
TCL 1.0X-40/D-ST	1.0X	40	6.2	0.054	9.26	370	0.03	0.08	1/2"(8㎜)	C
TCL 1.5X-40/D-ST	1.5X	40	5.3	0.063	11.9	211	0.03	0.25	1/2"(8㎜)	C
TCL 2.0X-40/D-ST	2.0X	40	4.8	0.07	14.28	142	0.03	0.03	1/2"(8㎜)	C
TCL 3.0X-40/D-ST	3.0X	40	4.8	0.07	21.5	95	0.02	0.26	1/2"(8㎜)	C
TCL 4.0X-40/D-ST	4.0X	40	4.8	0.07	28.6	71	0.02	0.2	1/2"(8㎜)	C
TCL 5.0X-40/D-ST	5.0X	40	4.2	0.08	31.25	50	0.02	0.05	1/2"(8㎜)	C
TCL 6.0X-40/D-ST	6.0X	40	4.2	0.08	37.4	41	0.02	0.02	1/2"(8㎜)	C
TCL 8.0X-40/D-ST	8.0X	40	4.2	0.08	50	31	0.01	0.03	1/2"(8㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

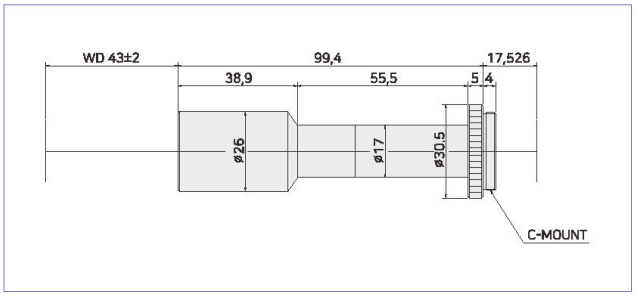
TCL 0.5X-40D-ST

Standard & Precision Optics



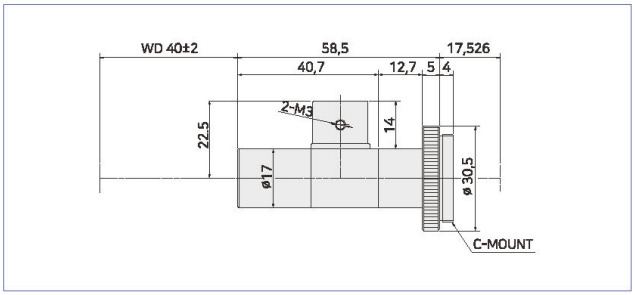
TCL 0.5X-40-ST

Standard & Precision Optics



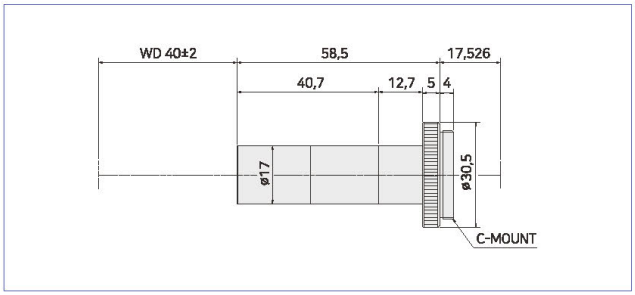
TCL 1.0X-40D-ST

Standard & Precision Optics



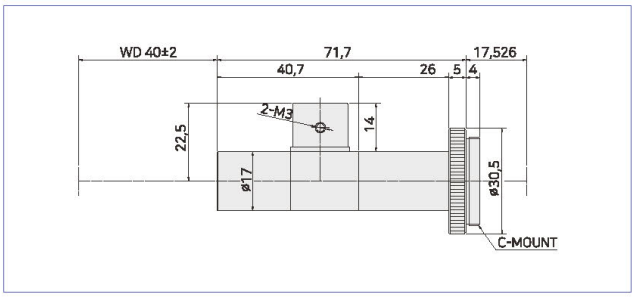
TCL 1.0X-40-ST

Standard & Precision Optics



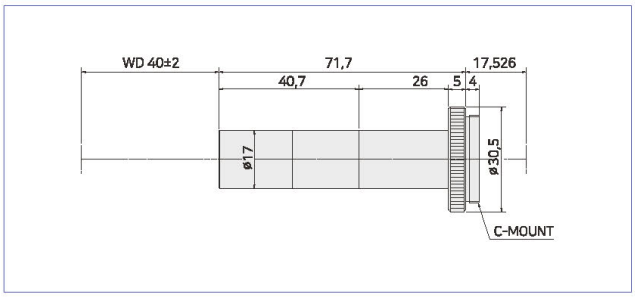
TCL 1.5X-40D-ST

Standard & Precision Optics



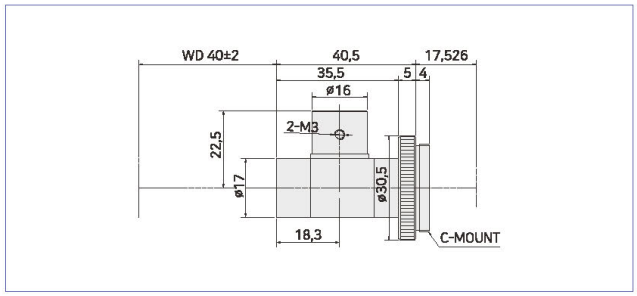
TCL 1.5X-40-ST

Standard & Precision Optics



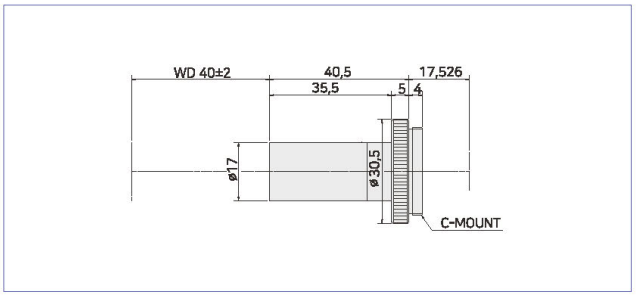
TCL 2.0X-40D-ST

Standard & Precision Optics



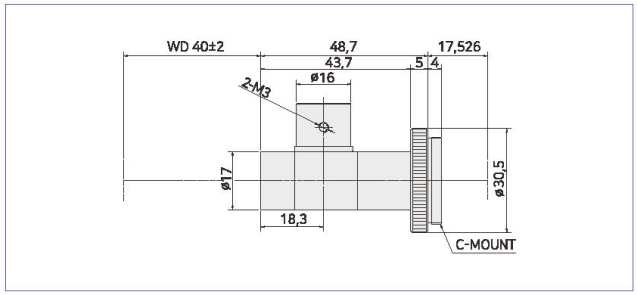
TCL 2.0X-40-ST

Standard & Precision Optics



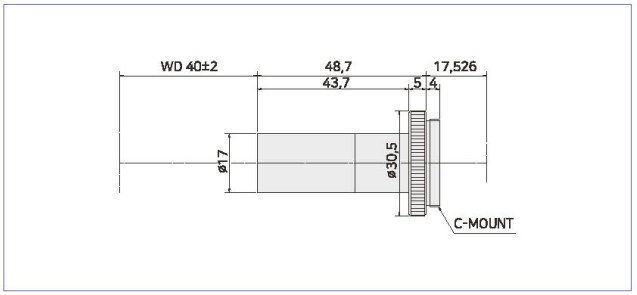
TCL 3.0X-40D-ST

Standard & Precision Optics



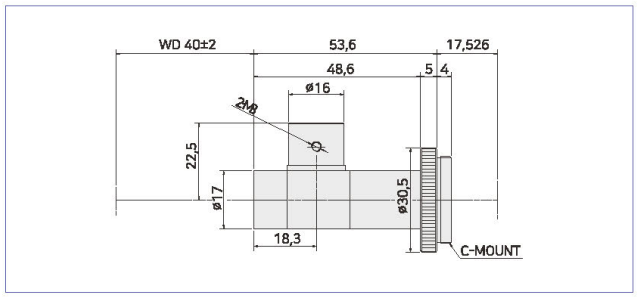
TCL 3.0X-40-ST

Standard & Precision Optics



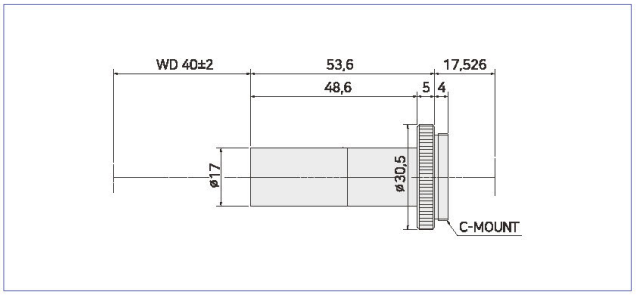
TCL 4.0X-40D-ST

Standard & Precision Optics



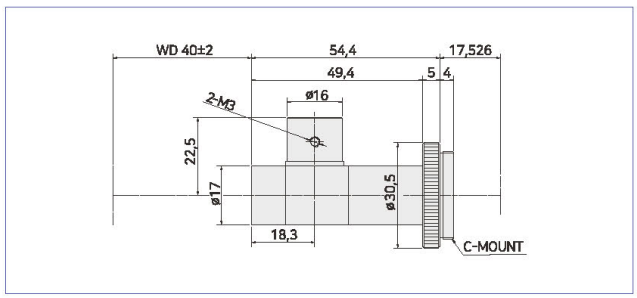
TCL 4.0X-40-ST

Standard & Precision Optics



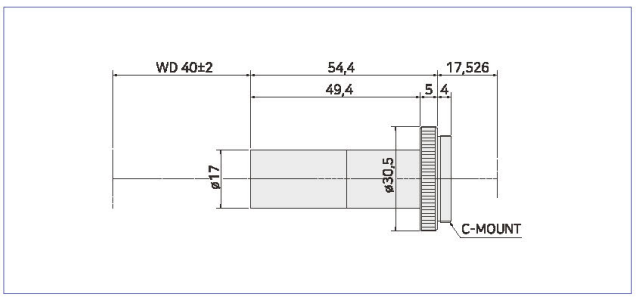
TCL 5.0X-40D-ST

Standard & Precision Optics



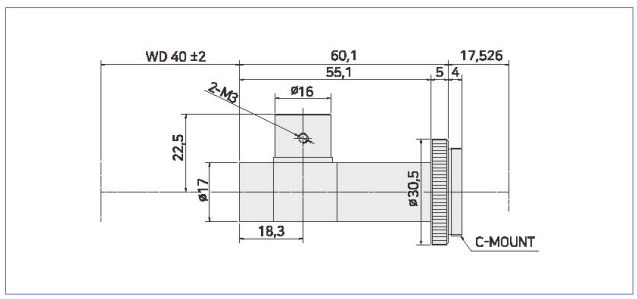
TCL 5.0X-40-ST

Standard & Precision Optics



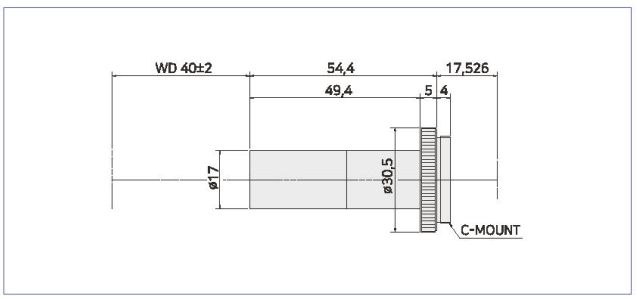
TCL 6.0X-40D-ST

Standard & Precision Optics



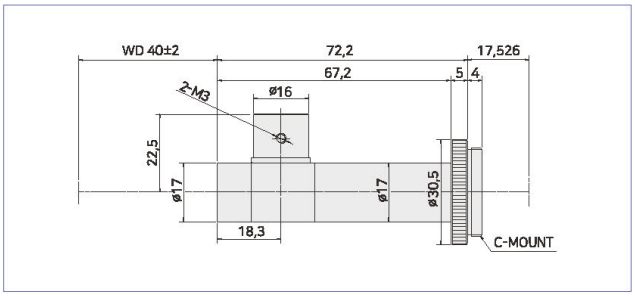
TCL 6.0X-40-ST

Standard & Precision Optics



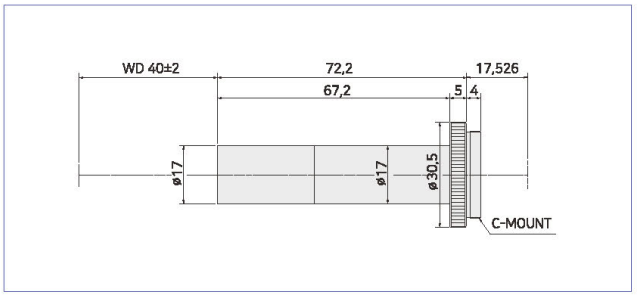
TCL 8.0X-40D-ST

Standard & Precision Optics



TCL 8.0X-40-ST

Standard & Precision Optics



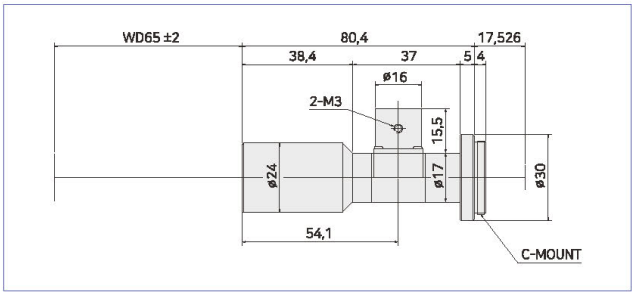
TCL-65-ST Series | W.D : 65㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (∠degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.5X-65/D-ST	0.5X	65	20.2	0.0166	15	2.4㎜	0.03	0.04	1/2"(8㎜)	C
TCL 0.8X-65/D-ST	0.8X	65	12.4	0.027	14.8	925	0.03	0.03	1/2"(8㎜)	C
TCL 1.0X-65/D-ST	1.0X	65	12.4	0.027	18.5	740	0.03	0.03	1/2"(8㎜)	C
TCL 1.5X-65/D-ST	1.5X	65	7	0.048	15.6	277	0.05	0.06	1/2"(8㎜)	C
TCL 2.0X-65/D-ST	2.0X	65	5.2	0.065	15.4	154	0.02	0.03	1/2"(8㎜)	C
TCL 3.0X-65/D-ST	3.0X	65	4.8	0.07	21.4	95	0.02	0.16	1/2"(8㎜)	C
TCL 4.0X-65/D-ST	4.0X	65	4.4	0.076	26.3	65	0.04	0.03	1/2"(8㎜)	C
TCL 5.0X-65/D-ST	5.0X	65.5	4.4	0.076	32.9	52	0.04	0.05	1/2"(8㎜)	C
TCL 6.0X-65/D-ST	6.0X	65.3	4.4	0.076	39.5	43	0.04	0.06	1/2"(8㎜)	C
TCL 8.0X-65/D-ST	8.0X	64.9	4.4	0.076	52.6	32	0.05	0.05	1/2"(8㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

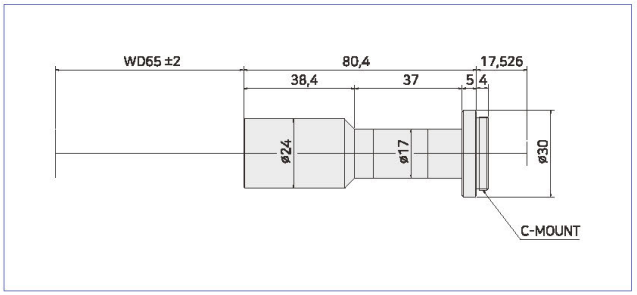
TCL 0.5X-65D-ST

Standard & Precision Optics



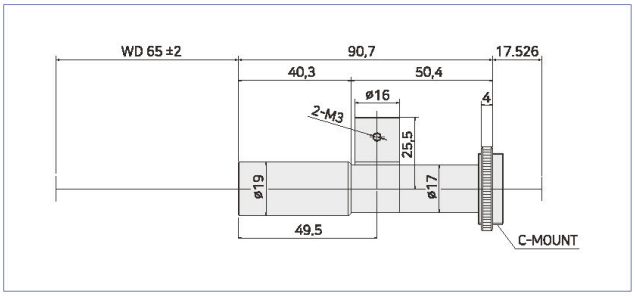
TCL 0.5X-65-ST

Standard & Precision Optics



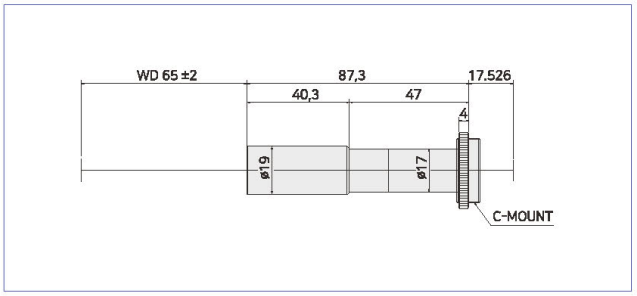
TCL 0.8X-65D-ST

Standard & Precision Optics



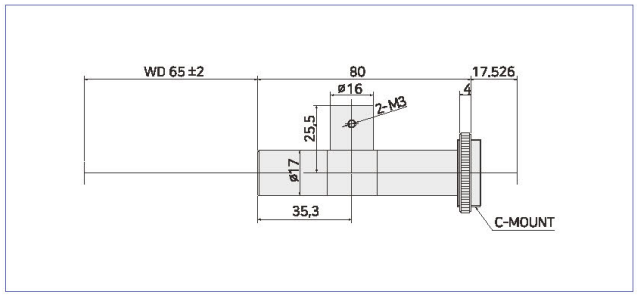
TCL 0.8X-65-ST

Standard & Precision Optics



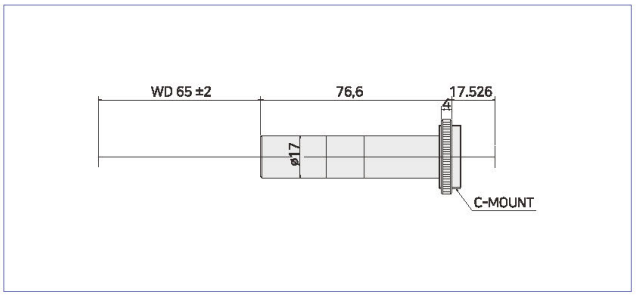
TCL 1.0X-65D-ST

Standard & Precision Optics



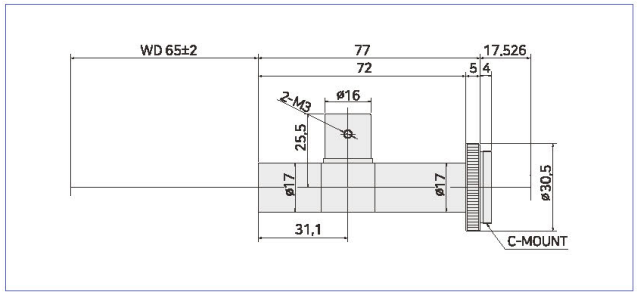
TCL 1.0X-65-ST

Standard & Precision Optics



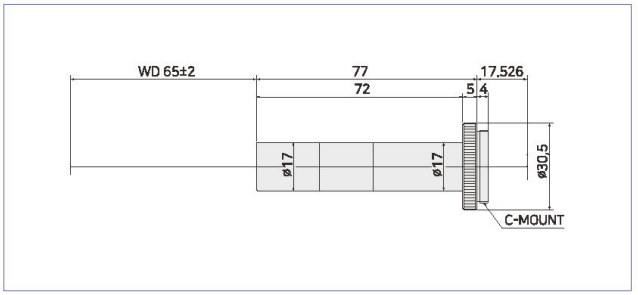
TCL 1.5X-65D-ST

Standard & Precision Optics



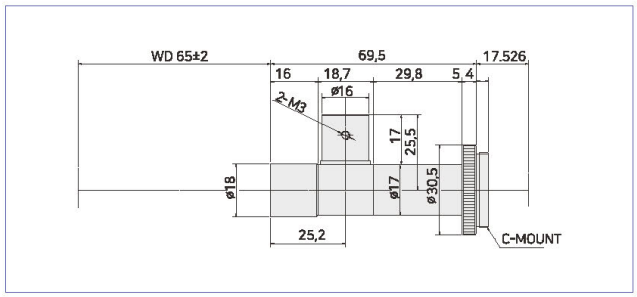
TCL 1.5X-65-ST

Standard & Precision Optics



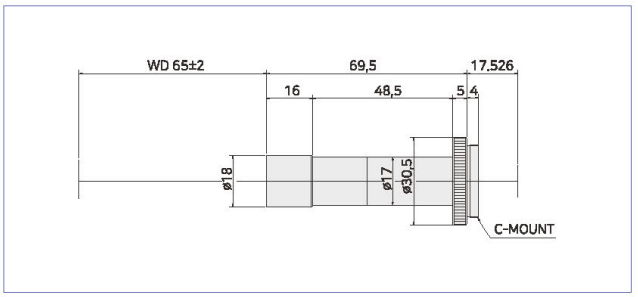
TCL 2.0X-65D-ST

Standard & Precision Optics



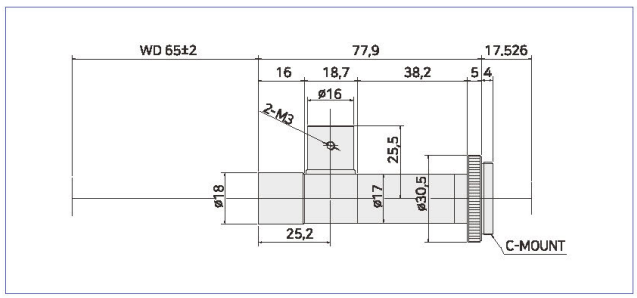
TCL 2.0X-65-ST

Standard & Precision Optics



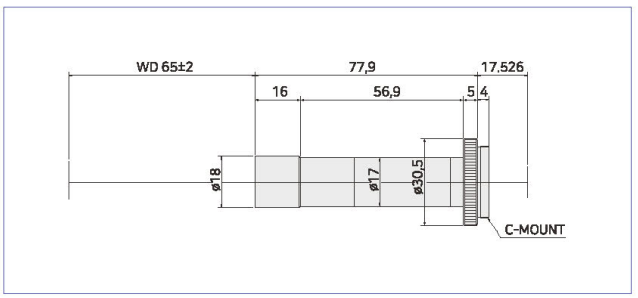
TCL 3.0X-65D-ST

Standard & Precision Optics



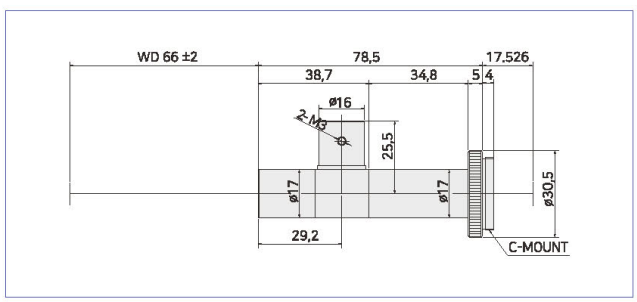
TCL 3.0X-65-ST

Standard & Precision Optics



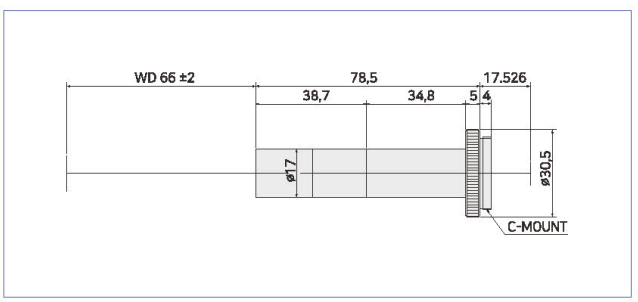
TCL 4.0X-65D-ST

Standard & Precision Optics



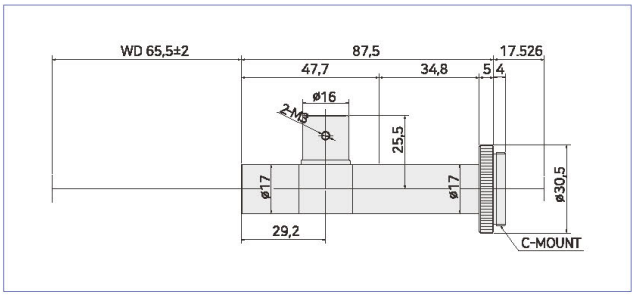
TCL 4.0X-65-ST

Standard & Precision Optics



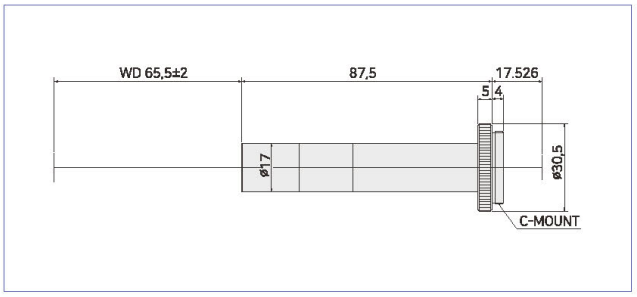
TCL 5.0X-65D-ST

Standard & Precision Optics



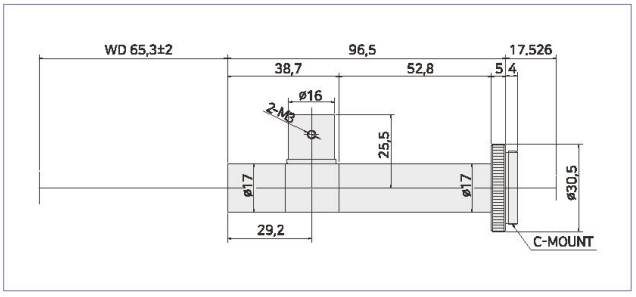
TCL 5.0X-65-ST

Standard & Precision Optics



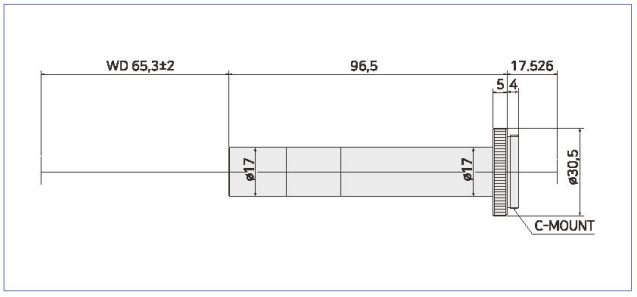
TCL 6.0X-65D-ST

Standard & Precision Optics



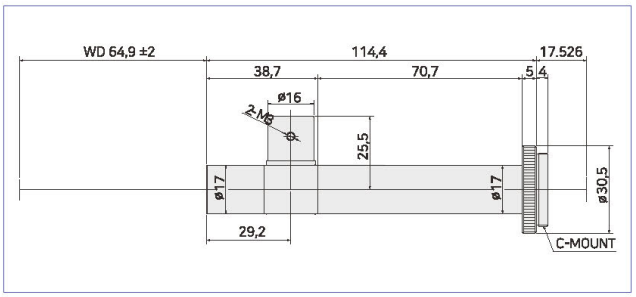
TCL 6.0X-65-ST

Standard & Precision Optics



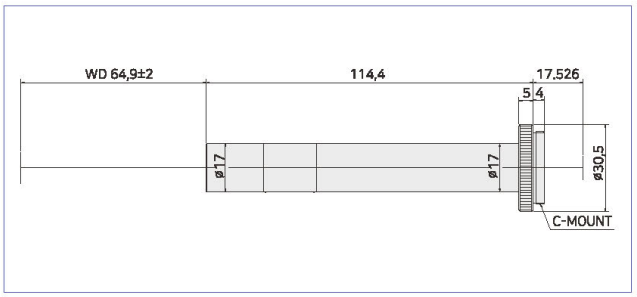
TCL 8.0X-65D-ST

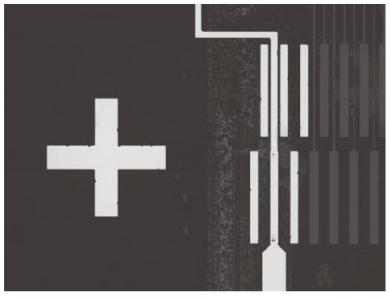
Standard & Precision Optics

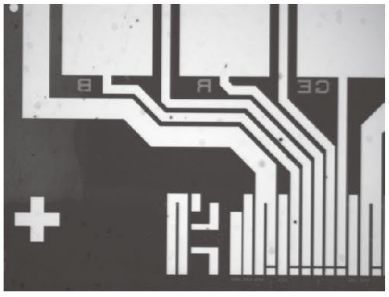


TCL 8.0X-65-ST

Standard & Precision Optics







- Wafer OCR, Wafer Pattern, Wafer Marking.
- LCD COG, LCD Align Mark.
- PDP Align, PDP OCR, TFT LCD Mark Alignment.

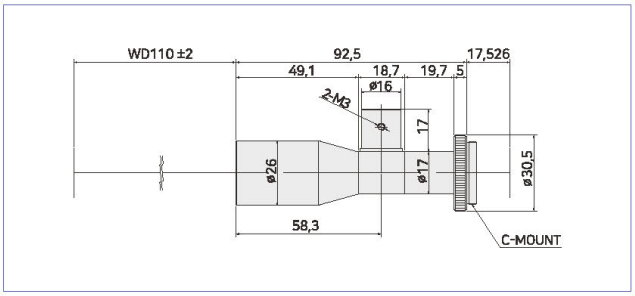
TCL-110-ST Series | W.D : 110mm

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (∠degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.5X-110/D-ST	0.5X	110	20	0.0166	15	2.4㎜	0.05	0.05	1/2"(8㎜)	C
TCL 0.8X-110/D-ST	0.8X	110	12	0.027	14.8	925	0.05	0.05	1/2"(8㎜)	C
TCL 1.0X-113/D-ST	1.0X	113	14	0.024	20.8	832	0.02	0.023	1/2"(8㎜)	C
TCL 1.2X-110D-ST-6	1.2X	110	10	0.033	18.2	505	0.03	0.03	1/3"(6㎜)	C
TCL 2.0X-110/D-ST	2.0X	110	7.5	0.045	22.2	222	0.02	0.02	1/2"(8㎜)	C
TCL 2.4X-110/D-ST	2.4X	107	7.5	0.045	26.7	185	0.02	0.07	1/2"(8㎜)	C
TCL 3.0X-110/D-ST	3.0X	110	6.1	0.055	27.3	121	0.01	0.14	1/2"(8㎜)	C
TCL 4.0X-110/D-ST	4.0X	110	5.6	0.06	33.3	83	0.01	0.16	1/2"(8㎜)	C
TCL 5.0X-110/D-ST	5.0X	110	5.6	0.06	41.7	66	0.01	0.14	1/2"(8㎜)	C
TCL 6.0X-110/D-ST	6.0X	110	5.6	0.06	50	55	0.01	0.1	1/2"(8㎜)	C
TCL 8.0X-110/D-ST	8.0X	110	5.6	0.06	66.7	41	0.015	0.25	1/2"(8㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

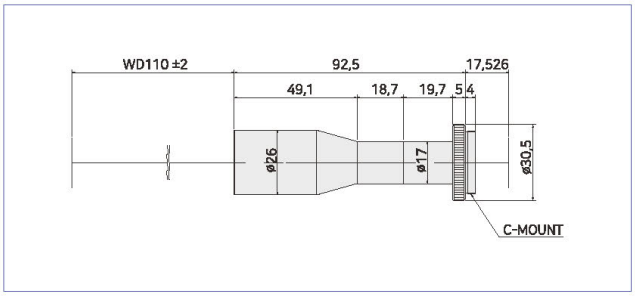
TCL 0.5X-110D-ST

Standard & Precision Optics



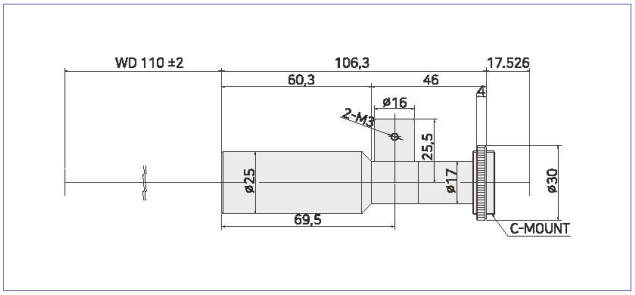
TCL 0.5X-110-ST

Standard & Precision Optics



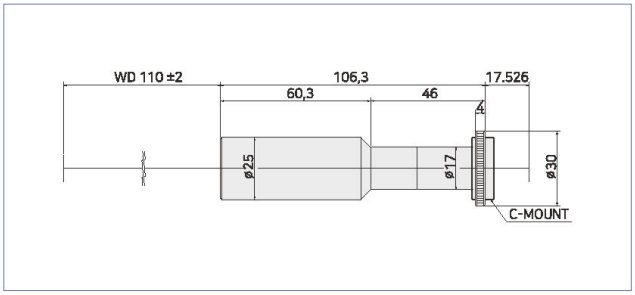
TCL 0.8X-110D-ST

Standard & Precision Optics



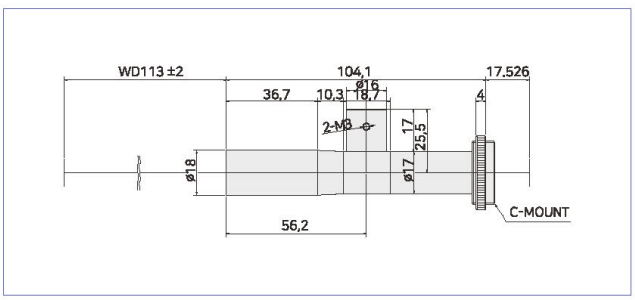
TCL 0.8X-110-ST

Standard & Precision Optics



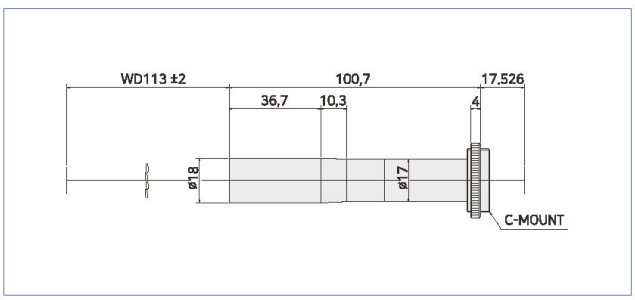
TCL 1.0X-113D-ST

Standard & Precision Optics

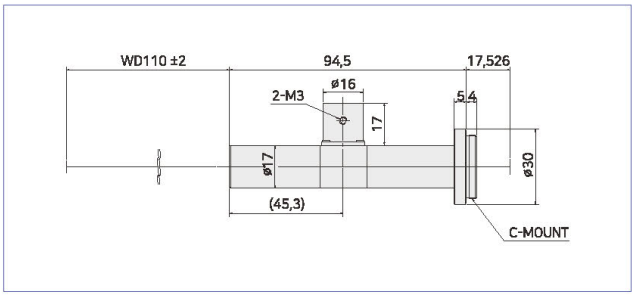


TCL 1.0X-113-ST

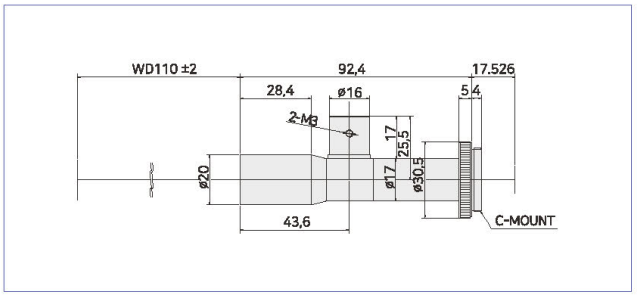
Standard & Precision Optics



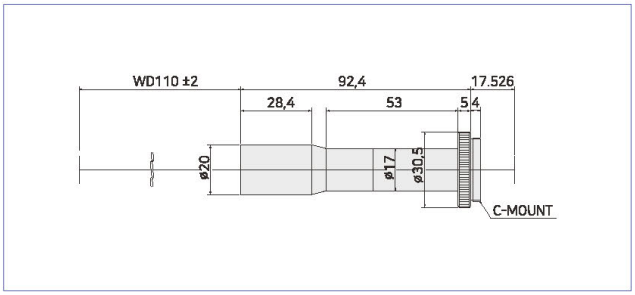
TCL 1.2X-110D-ST-6



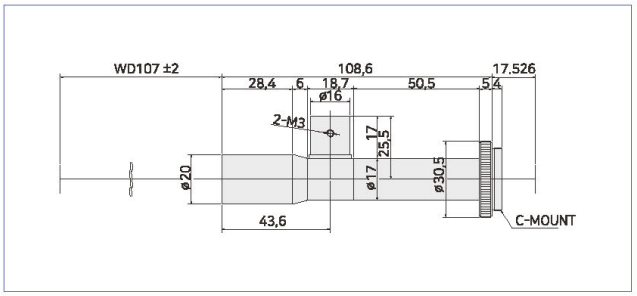
TCL 2.0X-110D-ST



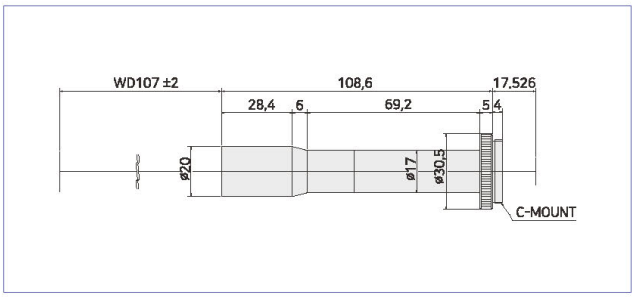
TCL 2.0X-110-ST



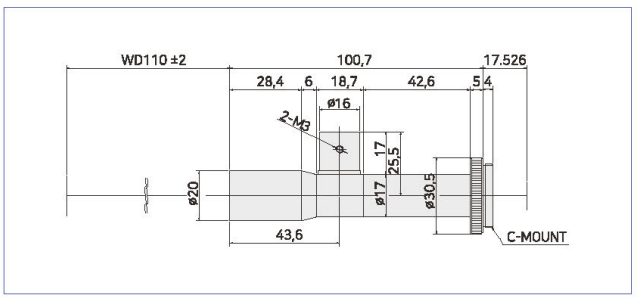
TCL 2.4X-110D-ST



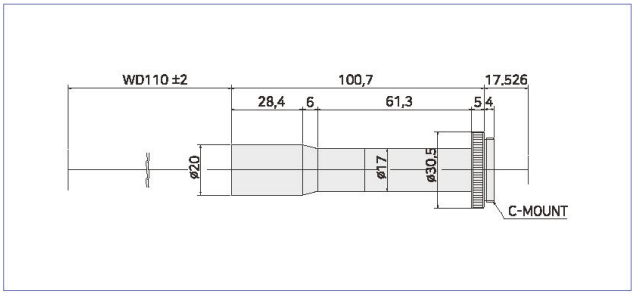
TCL 2.4X-110-ST



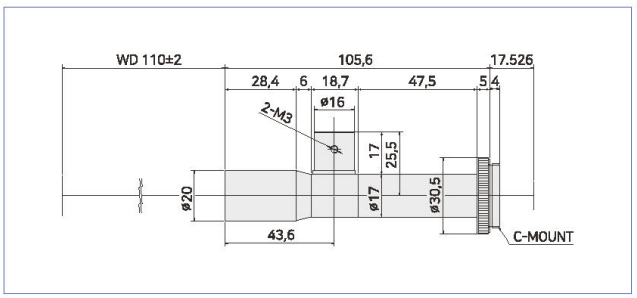
TCL 3.0X-110D-ST



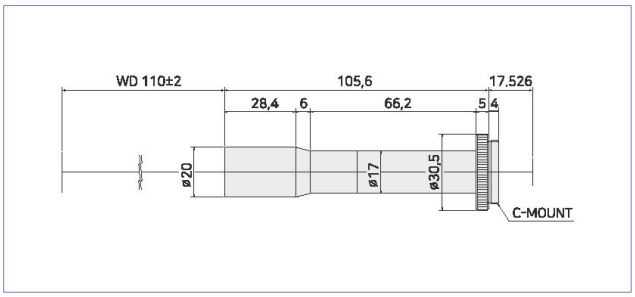
TCL 3.0X-110-ST



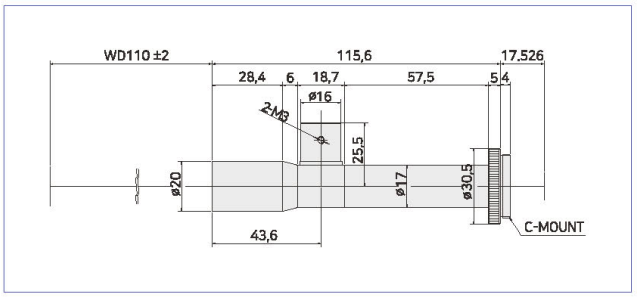
TCL 4.0X-110D-ST



TCL 4.0X-110-ST

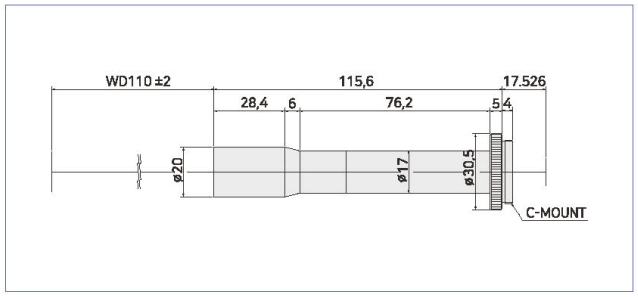


TCL 5.0X-110D-ST



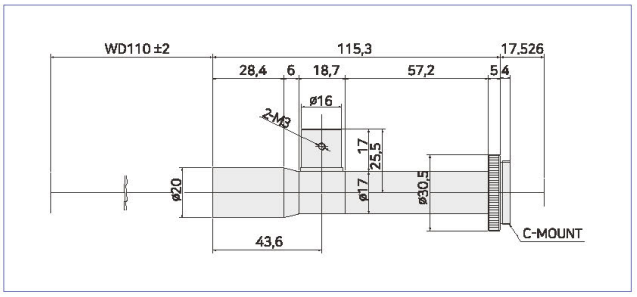
TCL 5.0X-110-ST

Standard & Precision Optics



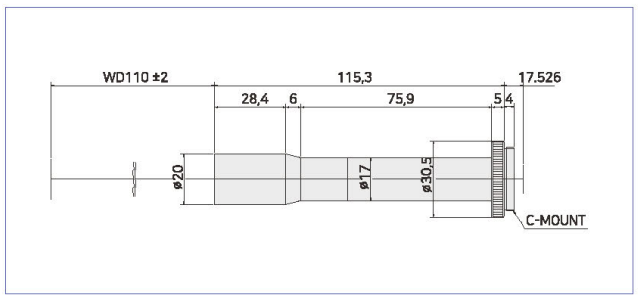
TCL 6.0X-110D-ST

Standard & Precision Optics



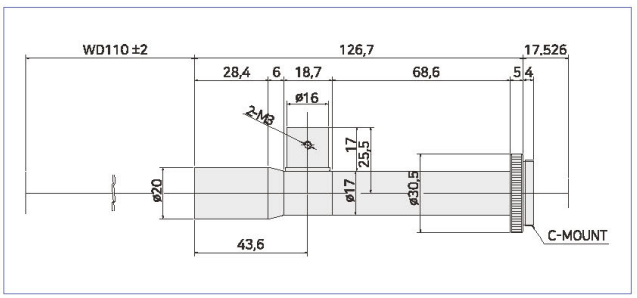
TCL 6.0X-110-ST

Standard & Precision Optics



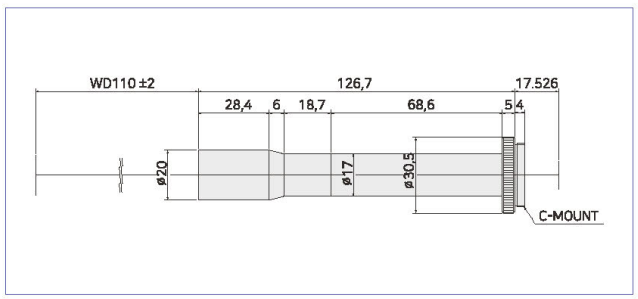
TCL 8.0X-110D-ST

Standard & Precision Optics



TCL 8.0X-110-ST

Standard & Precision Optics

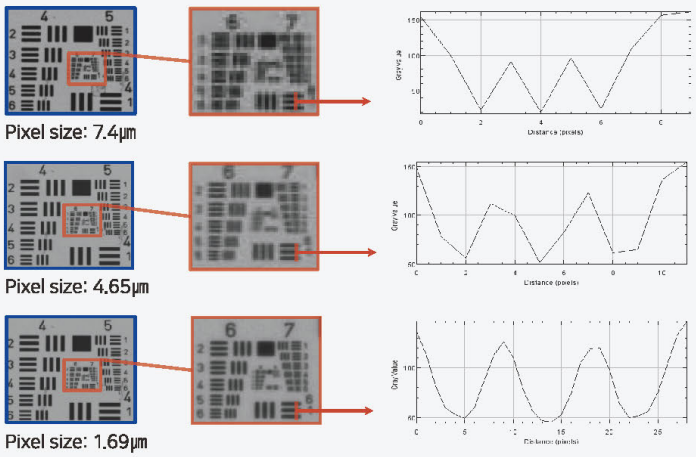


TIP

Standard & Precision Optics

Sensor Pixel Size & Image Sharpness

Model : TCL1.0X-65D-5M (Resolution : 4.8μm) : Image variation for sensor pixel size



It shows the sharpness variation of the images according to the sensor pixel size for certain lens which is TCL1.0X-65D-5M.

Choosing the proper pixel size for lens is critical point to decide what is the best way to get the clear image for certain pixel. As the sensor size is getting more precise, the image quality of the lens should be better.

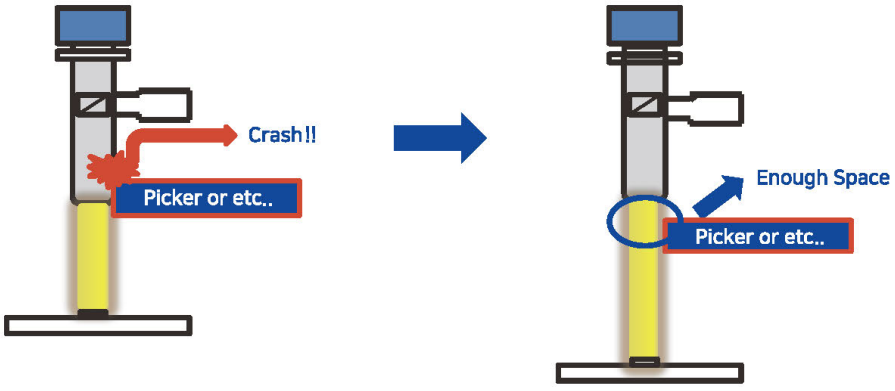
However, we have to note certainly that the lens performance also has to be supported in order to satisfy this point.

Standard & Precision Optics

TCL-L.W.D Series

FEATURES

- Long working distance telecentric lenses from 150 to 400㎜.
- Good for the easy to alignment application where requested long W.D.
- There are 4 types of W.D lenses those are 150, 220, 300, 400㎜.
- It is very low distortion design & high resolution telecentric lens.
- Support up to Max. 11㎜ diagonal length.

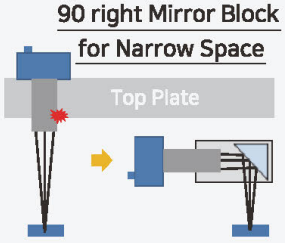


Standard W.D **Long Working W.D (L.W.D)**

There is required to enough space to prevent for crash when handler moves like picker in the equipment.
Finally, L.W.D (Long Working Distance) will be needed to get the enough space.
SPO have various L.W.D from 156㎜ to 405㎜ also possible to make more longer W.D.

Standard & Precision Optics

If there is no enough space ?



This mirror block is useful when there is limited space.
Final image becomes mirror images.

TCL 1.0X-156/D-ST Align mark image

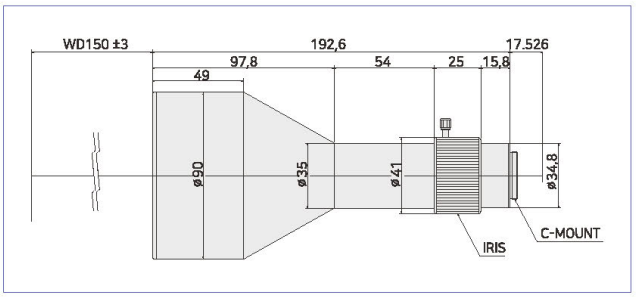
TCL-150-LWD Series | W.D : 150㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (∝degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.1X-150I-HR-8	0.1X	150	40.4	0.0083	6	24㎜	0.04	0.05	1/2"(8㎜)	C
TCL 0.8X-173/D-ST	0.8X	173	11.2	0.03	13.3	831	0.04	0.07	1/2"(8㎜)	C
TCL 1.0X-156/D-ST	1.0X	156	8.8	0.038	13.2	528	0.04	0.07	1/2"(8㎜)	C
TCL 1.0X-190I-HR-8	1.0X	190	6.7	0.05	10	400	0.05	0.03	1/2"(8㎜)	C
TCL 1.2X-173/D-ST	1.2X	173	11.2	0.03	20	555	0.04	0.13	1/2"(8㎜)	C
TCL 1.5X-156/D-ST	1.5X	156	8.8	0.038	19.7	350	0.04	0.16	1/2"(8㎜)	C
TCL 1.6X-173/D-ST	1.6X	173	11.2	0.03	26.7	417	0.04	0.18	1/2"(8㎜)	C
TCL 2.0X-156/D-ST	2.0X	156	8.8	0.038	26.3	263	0.04	0.19	1/2"(8㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

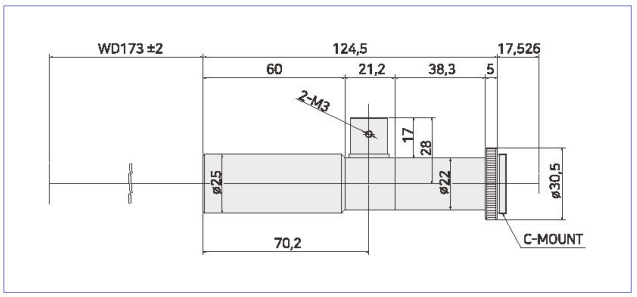
TCL 0.1X-150I-HR-8

Standard & Precision Optics



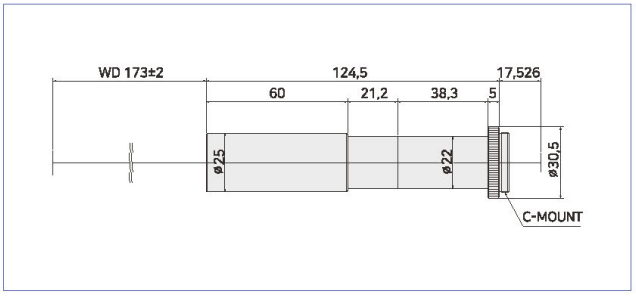
TCL 0.8X-173D-ST

Standard & Precision Optics



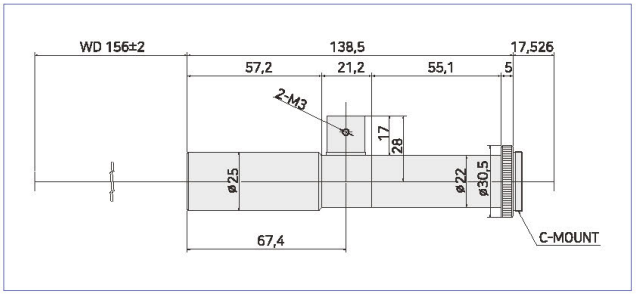
TCL 0.8X-173-ST

Standard & Precision Optics



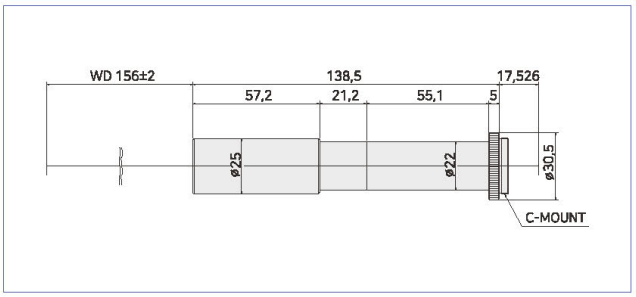
TCL 1.0X-156D-ST

Standard & Precision Optics



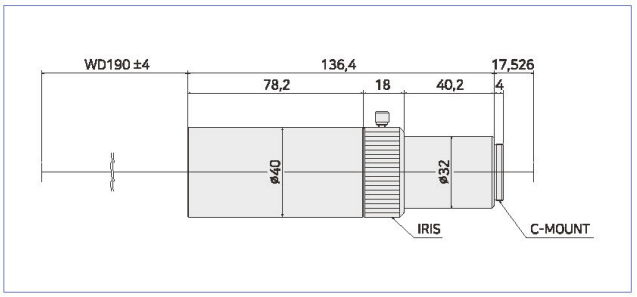
TCL 1.0X-156-ST

Standard & Precision Optics



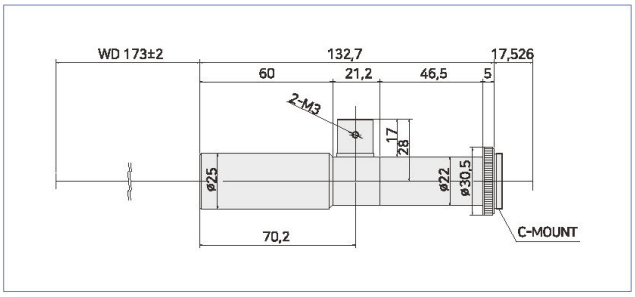
TCL 1.0X-190I-HR-8

Standard & Precision Optics



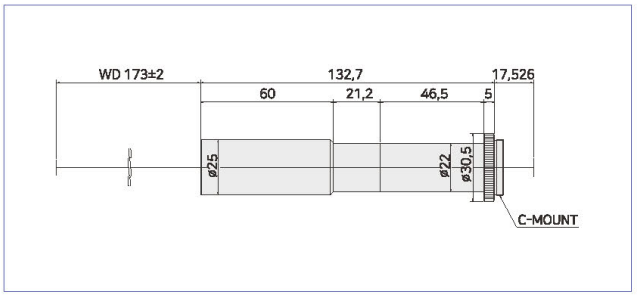
TCL 1.2X-173D-ST

Standard & Precision Optics



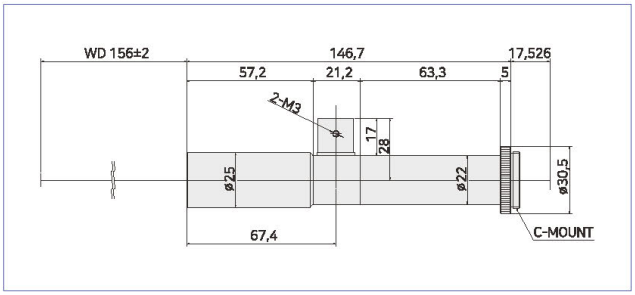
TCL 1.2X-173-ST

Standard & Precision Optics



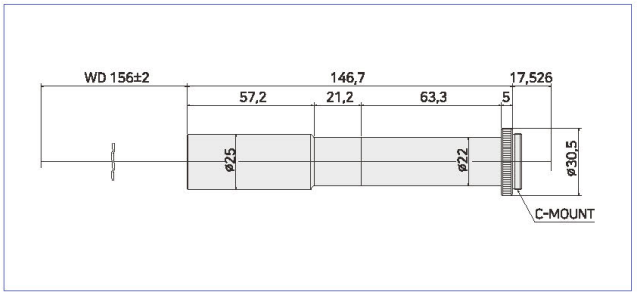
TCL 1.5X-156D-ST

Standard & Precision Optics



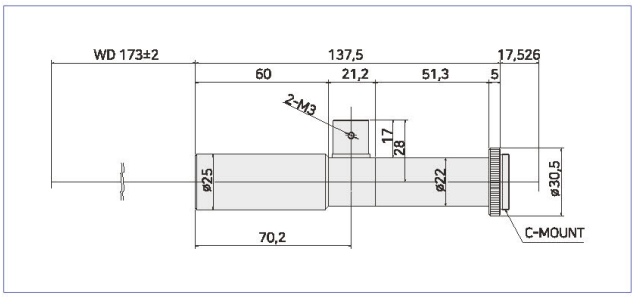
TCL 1.5X-156-ST

Standard & Precision Optics



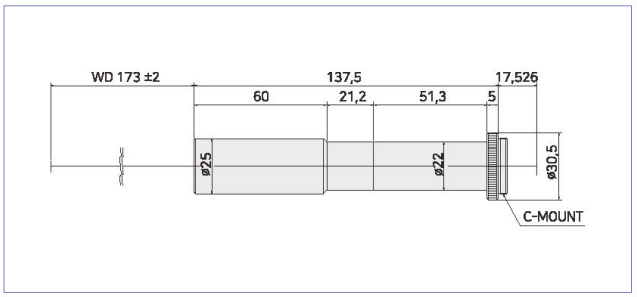
TCL 1.6X-173D-ST

Standard & Precision Optics



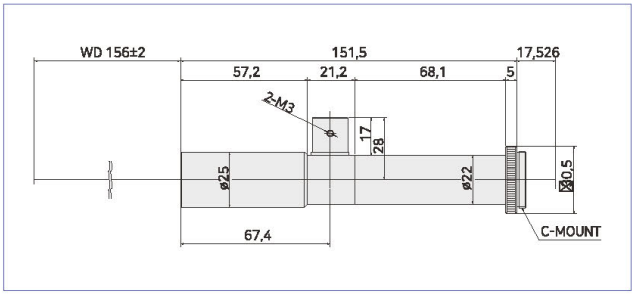
TCL 1.6X-173-ST

Standard & Precision Optics



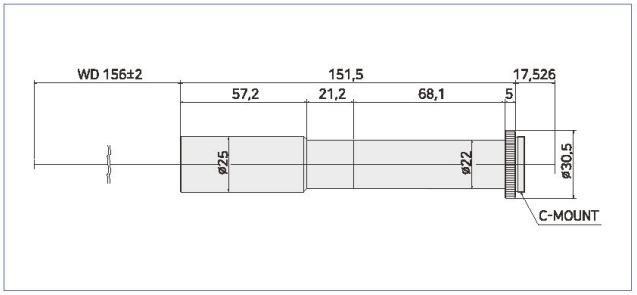
TCL 2.0X-156D-ST

Standard & Precision Optics



TCL 2.0X-156-ST

Standard & Precision Optics



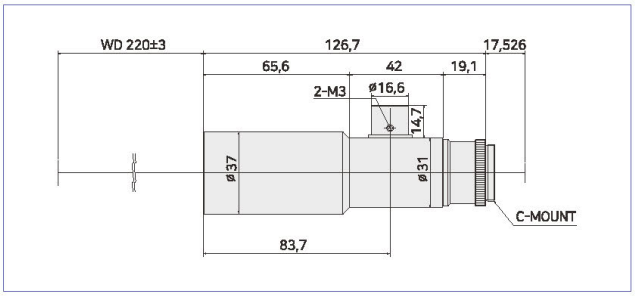
TCL-220-LWD Series | W.D : 220㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (∠degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.75X-220/D-8	0.75X	220	8.9	0.0375	10	711	0.03	0.08	1/2"(8㎜)	C
TCL 0.75X-220/D	0.75X	220	9.1	0.037	10	711	0.03	0.02	2/3"(11㎜)	C
TCL 1.0X-220/D	1.0X	220	7.4	0.045	11	440	0.03	0.01	2/3"(11㎜)	C
TCL 1.0X-250/D-9	1.0X	250	7.4	0.045	11	440	0.03	0.081	1/1.8"(9㎜)	C
TCL 1.5X-200/D	1.5X	200	5	0.067	11.2	199	0.03	0.08	2/3"(11㎜)	C
TCL 1.5X-220/D-8	1.5X	220	7.4	0.045	16.6	295	0.03	0.13	1/2"(8㎜)	C
TCL 2.0X-200/D-8	2.0X	200	4.2	0.08	12.5	125	0.03	0.02	1/2"(8㎜)	C
TCL 2.0X-220/D-11	2.0X	220	6.7	0.05	20	200	0.03	0.07	2/3"(11㎜)	C
TCL 2.5X-220/D-11	2.5X	220	6.7	0.05	25	160	0.03	0.08	2/3"(11㎜)	C
TCL 3.0X-200/D-8	3.0X	200	4.2	0.08	18.7	83	0.02	0.1	1/2"(8㎜)	C
TCL 4.0X-200/D-8	4.0X	200	4.2	0.08	25	62	0.015	0.13	1/2"(8㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

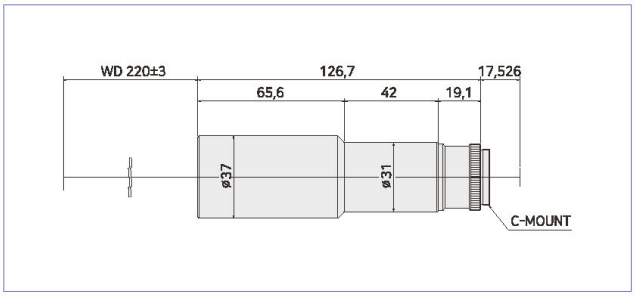
TCL 0.75X-220D-8

Standard & Precision Optics



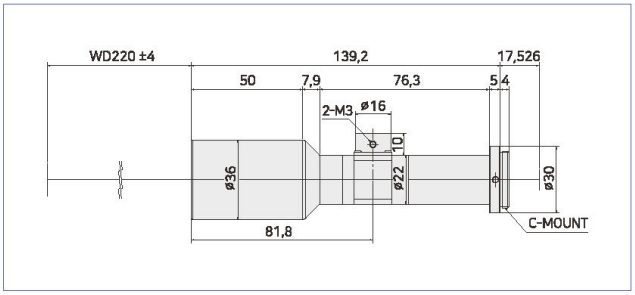
TCL 0.75X-220-8

Standard & Precision Optics



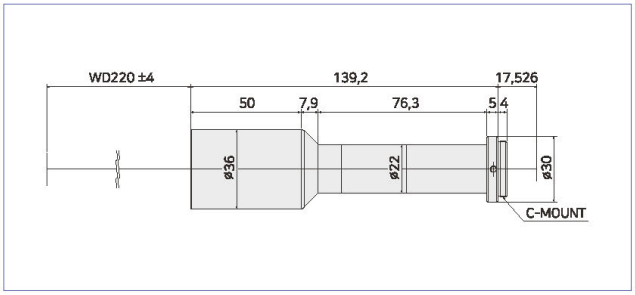
TCL 0.75X-220D

Standard & Precision Optics



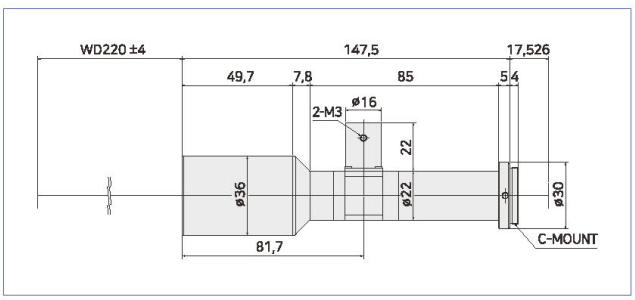
TCL 0.75X-220

Standard & Precision Optics



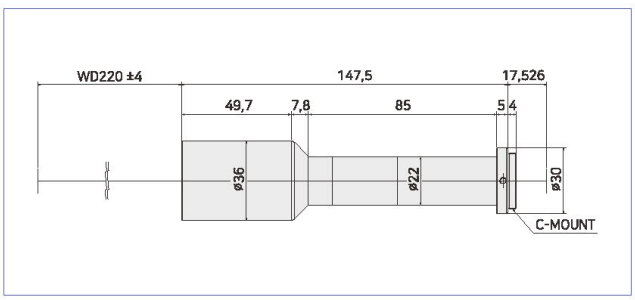
TCL 1.0X-220D

Standard & Precision Optics



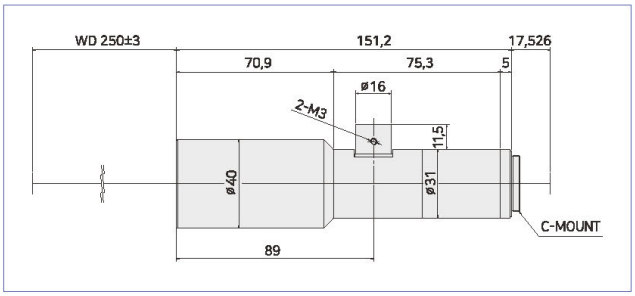
TCL 1.0X-220

Standard & Precision Optics



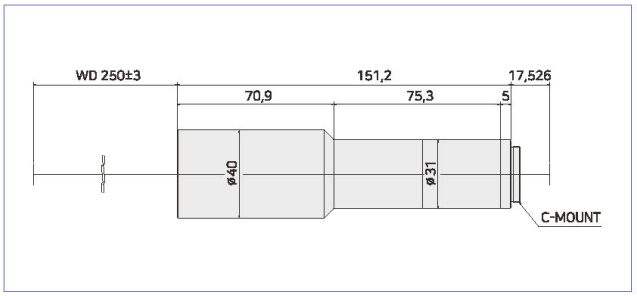
TCL 1.0X-250D-9

Standard & Precision Optics



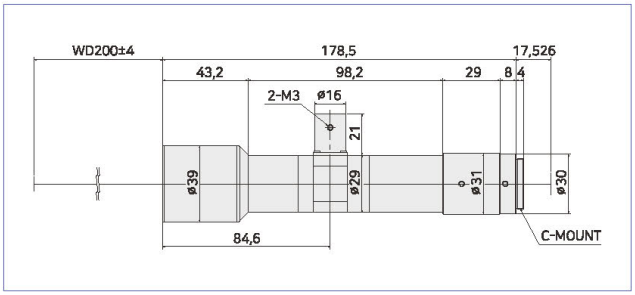
TCL 1.0X-250-9

Standard & Precision Optics



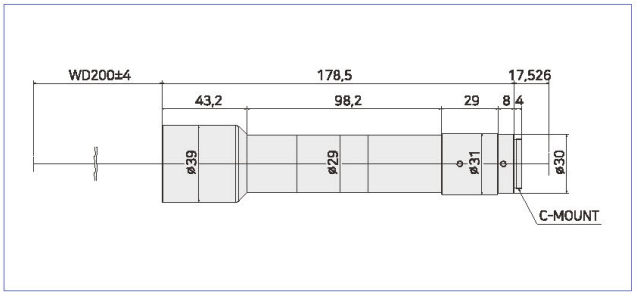
TCL 1.5X-200D

Standard & Precision Optics



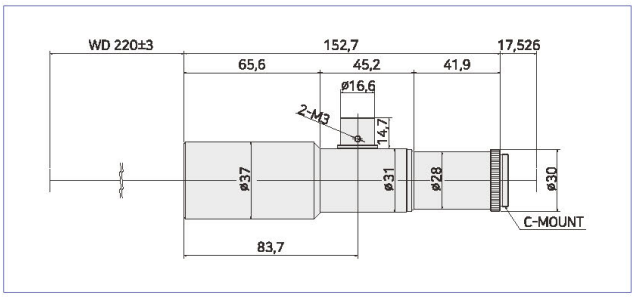
TCL 1.5X-200

Standard & Precision Optics



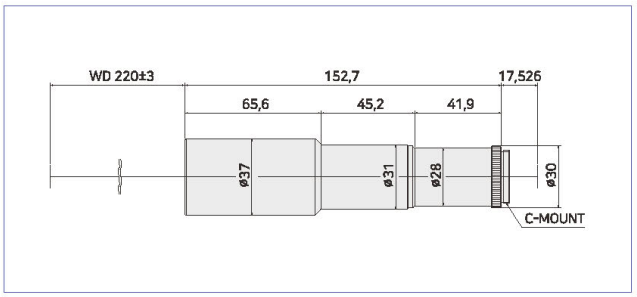
TCL 1.5X-220D-8

Standard & Precision Optics



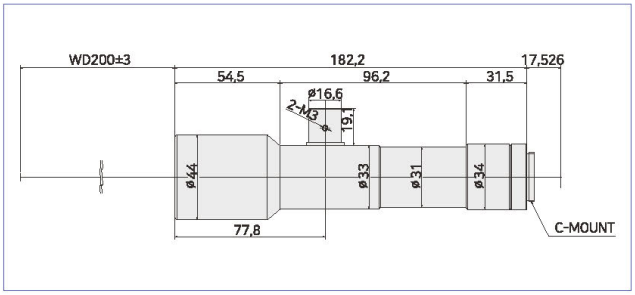
TCL 1.5X-220-8

Standard & Precision Optics



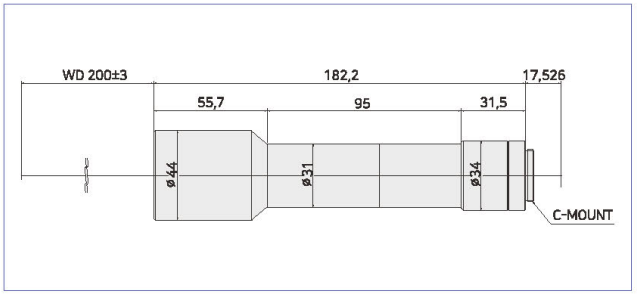
TCL 2.0X-200D-8

Standard & Precision Optics



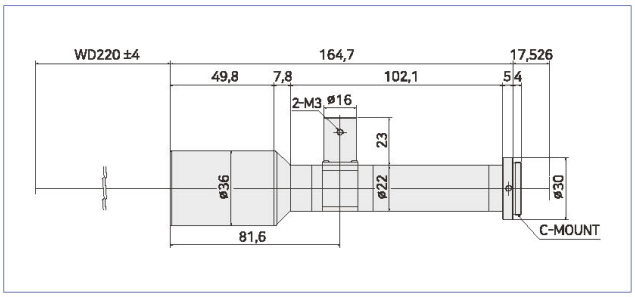
TCL 2.0X-200-8

Standard & Precision Optics



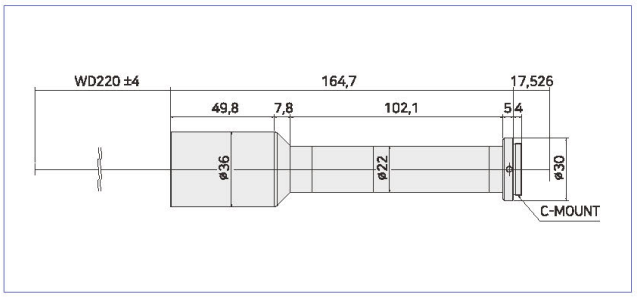
TCL 2.0X-220D-11

Standard & Precision Optics



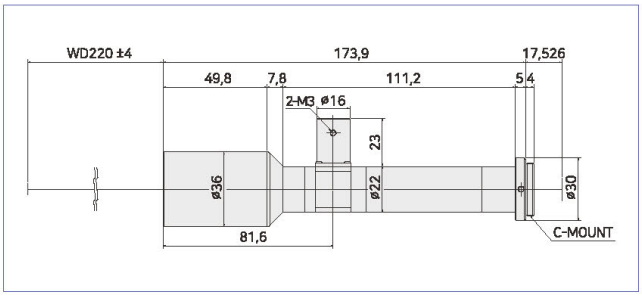
TCL 2.0X-220-11

Standard & Precision Optics



TCL 2.5X-220D-11

Standard & Precision Optics



TCL 2.5X-220-11

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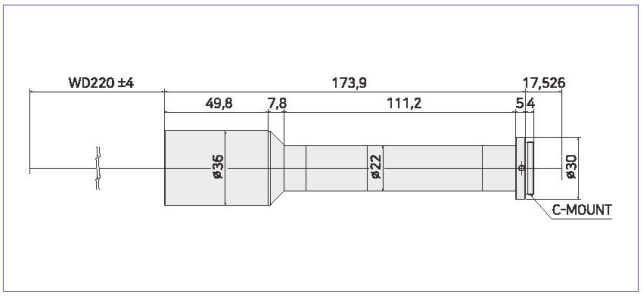
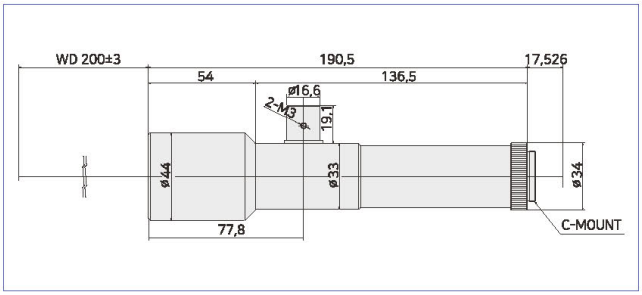


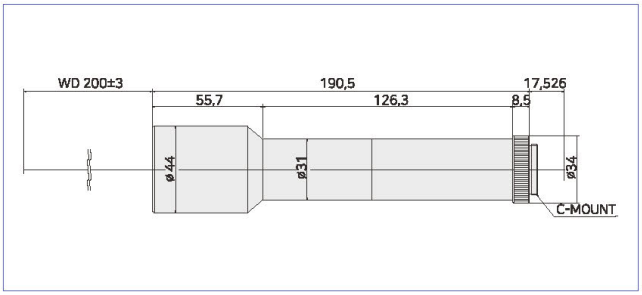
TCL 3.0X-200D-8

Standard & Precision Optics



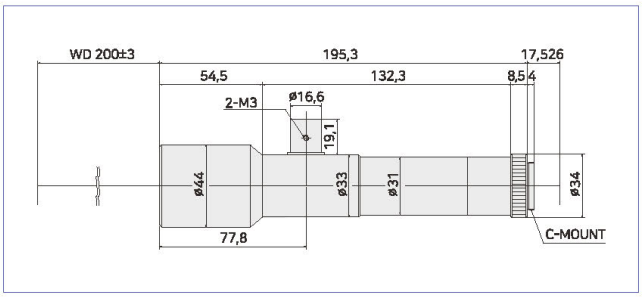
TCL 3.0X-200-8

Standard & Precision Optics



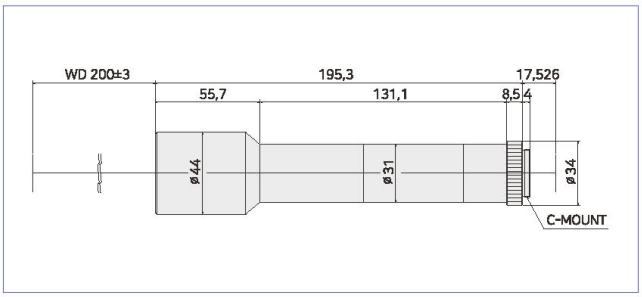
TCL 4.0X-200D-8

Standard & Precision Optics



TCL 4.0X-200-8

Standard & Precision Optics



L.W.D lenses will be quite good for the limited space between lens and specimen in the equipment.
Therefore, there are so many options according to magnification and W.D that you can choose suitable lens more easily.
SPO can make the customized lens for customer's requirement if you need special lenses.

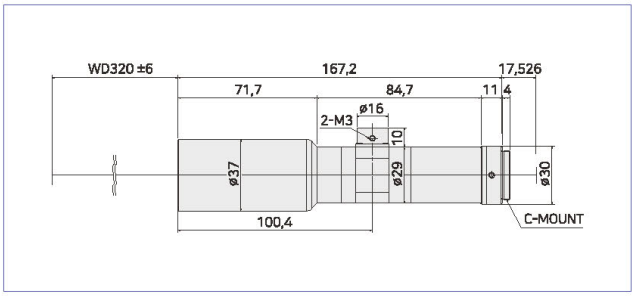
TCL-300 & 400-LWD Series | W.D : 300 & 400㎜

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (∝degree)	Optical Distortion (%)	Sensor size	Mount
TCL 0.8X-320/D	0.8X	320	12.0	0.028	14.0	875	0.03	0.03	1/2"(8㎜)	C
TCL 1.0X-300/D	1.0X	300	9.6	0.035	14.3	572	0.02	0.03	1/2"(8㎜)	C
TCL 1.0X-340/D	1.0X	340	8.4	0.04	12.5	500	0.03	0.04	1/2"(8㎜)	C
TCL 1.5X-300/D	1.5X	300	9.6	0.035	21.4	380	0.02	0.13	1/2"(8㎜)	C
TCL 2.0X-300/D	2.0X	300	9.6	0.035	28.6	286	0.01	0.17	1/2"(8㎜)	C
TCL 2.0X-330/D-11	2.0X	330	10.2	0.033	30.0	300	0.03	0.03	2/3"(11㎜)	C
TCL 3.0X-340/D-11	3.0X	340	13.4	0.025	60	266	0.03	0.2	2/3"(11㎜)	C
TCL 0.5X-402/D	0.5X	402	12.9	0.026	9.6	1.5㎜	0.03	0.05	1/2"(8㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

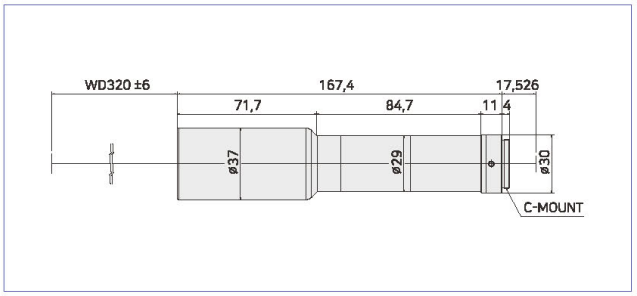
TCL 0.8X-320D

Standard & Precision Optics



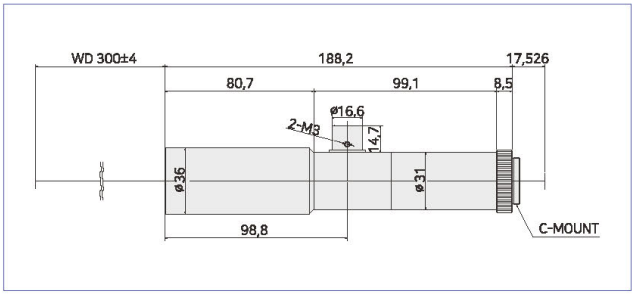
TCL 0.8X-320

Standard & Precision Optics



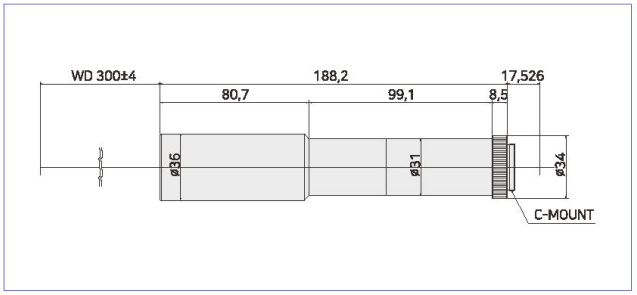
TCL 1.0X-300D

Standard & Precision Optics



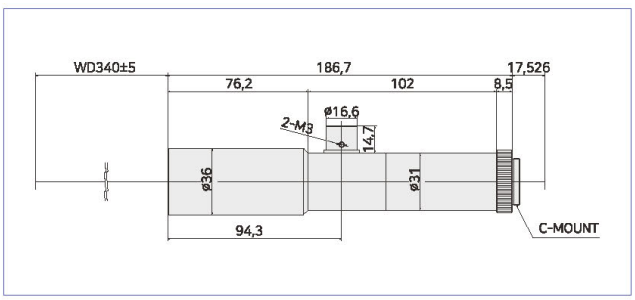
TCL 1.0X-300

Standard & Precision Optics



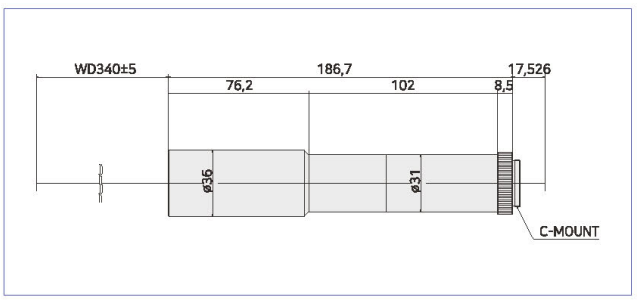
TCL 1.0X-340D

Standard & Precision Optics



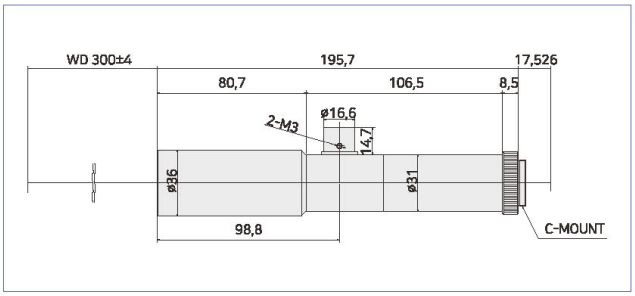
TCL 1.0X-340

Standard & Precision Optics



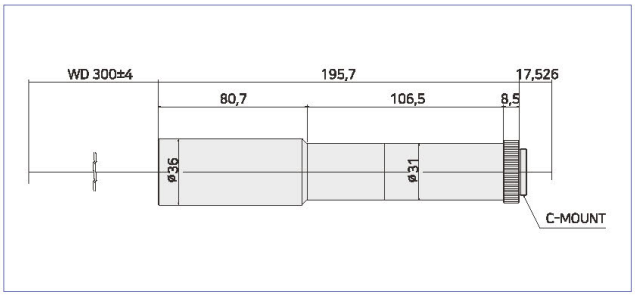
TCL 1.5X-300D

Standard & Precision Optics



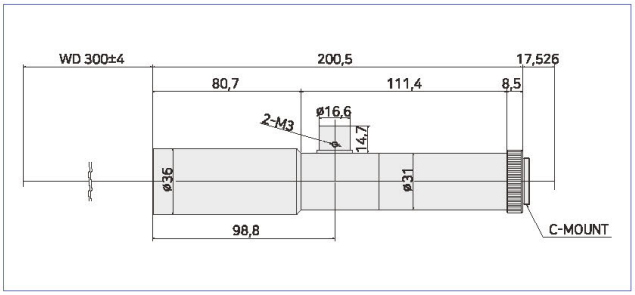
TCL 1.5X-300

Standard & Precision Optics



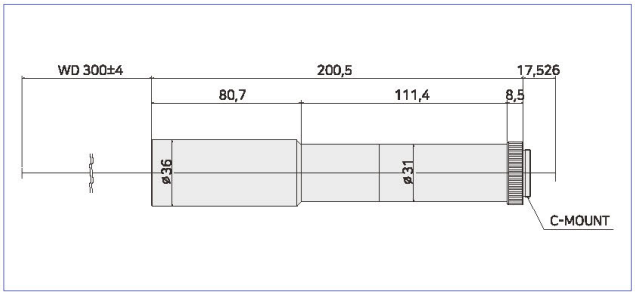
TCL 2.0X-300D

Standard & Precision Optics



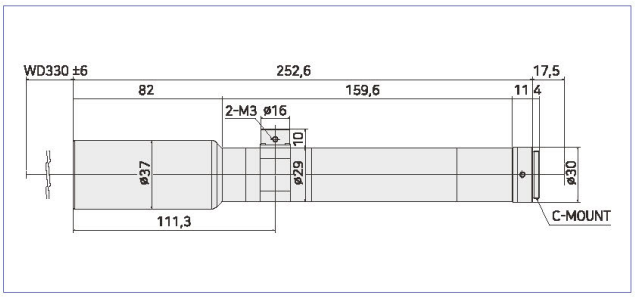
TCL 2.0X-300

Standard & Precision Optics



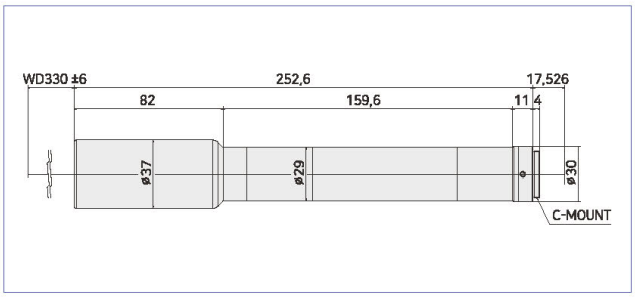
TCL 2.0X-330D-11

Standard & Precision Optics



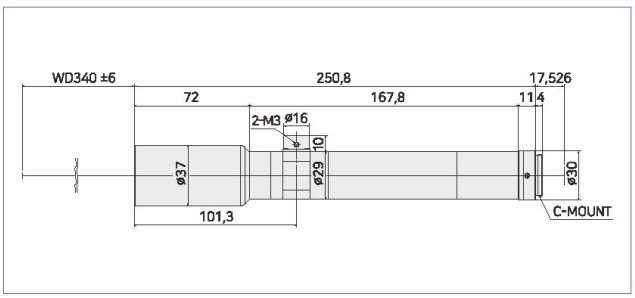
TCL 2.0X-330-11

Standard & Precision Optics



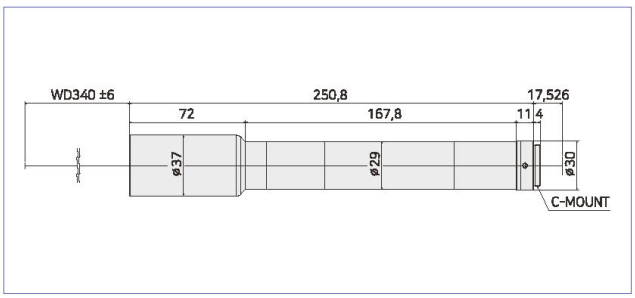
TCL 3.0X-340D-11

Standard & Precision Optics



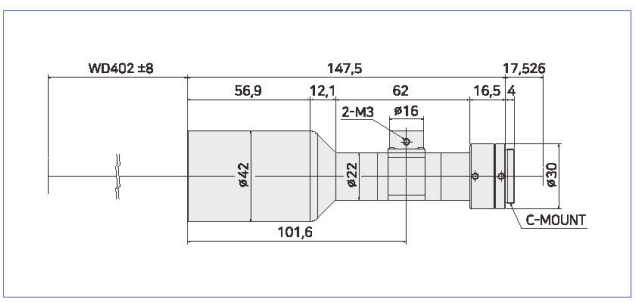
TCL 3.0X-340-11

Standard & Precision Optics



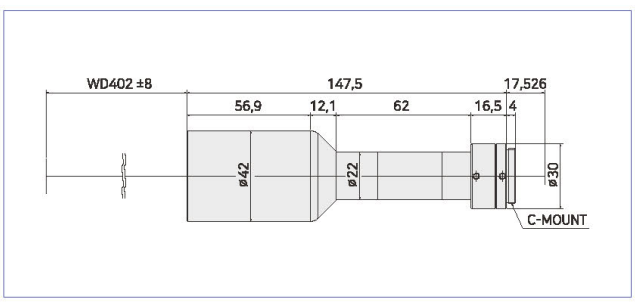
TCL 0.5X-402D

Standard & Precision Optics



TCL 0.5X-402

Standard & Precision Optics



Standard & Precision Optics

Non-Telecentric Lens Series

FEATURES

- Good for any measurement application like factory automation which is not required telecentricity.
- Nearly zero distortion design.
- Fixed magnification lens and compact size.

Non-Telecentric lens(NTL) series have designed for high resolution and nearly zero distortion perfectly. It is good that compact size making and cost-effective optics. Also it can replace the cctv lens.
This series are fixed magnification will be useful to be precise measurement applications. In addition to, it is so rigid and solid that really good for flying machine which required stability condition even if it moves fast.
SPO can support many types of camera sensors from ½" to 15M with high image quality.
Therefore, it is possible to modify another magnification according to the customer's requirement.

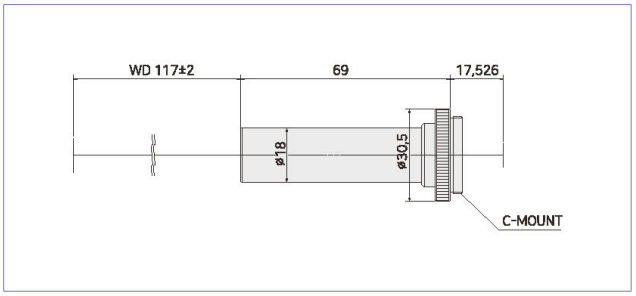
General Lens

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Optical Distortion (%)	Sensor size	Mount
NTL 0.6X-117	0.6X	117	9.3	0.036	8.3	922	0.02	1/2"(8㎜)	C
NTL 0.6X-120	0.6X	120	9.3	0.036	8.3	922	0.04	1/2"(8㎜)	C
NTL 0.8X-100	0.8X	100	8.2	0.041	9.7	606	0.03	1/2"(8㎜)	C
NTL 1.2X-100	1.2X	100	7.8	0.043	14	388	0.03	1/2"(8㎜)	C
NTL 2.0X-100	2.0X	100	7.1	0.047	21.3	213	0.04	1/2"(8㎜)	C
NTL 4.0X-92	4.0X	92	6.1	0.055	36.4	91	0.01	1/2"(8㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

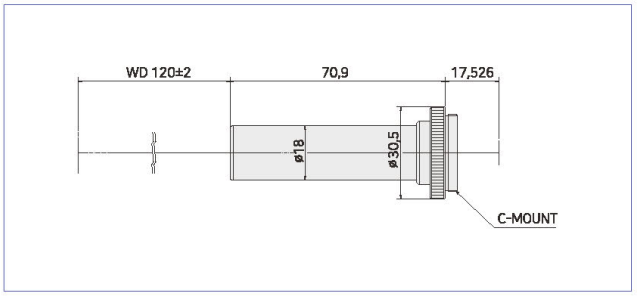
NTL 0.6X-117

Standard & Precision Optics



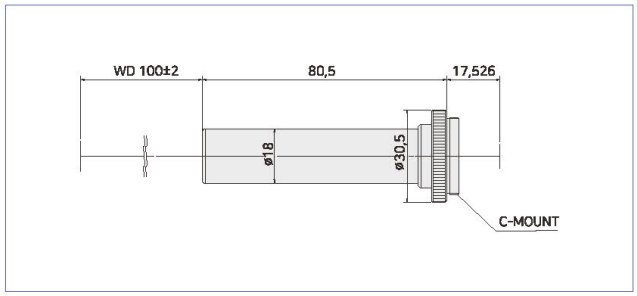
NTL 0.6X-120

Standard & Precision Optics



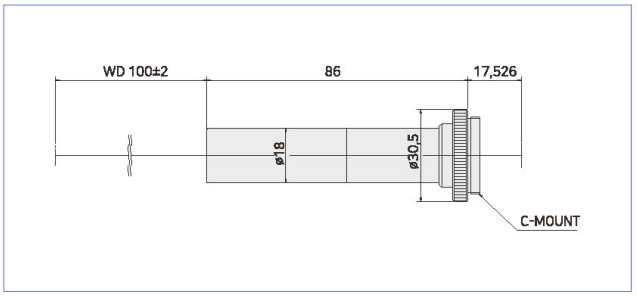
NTL 0.8X-100

Standard & Precision Optics



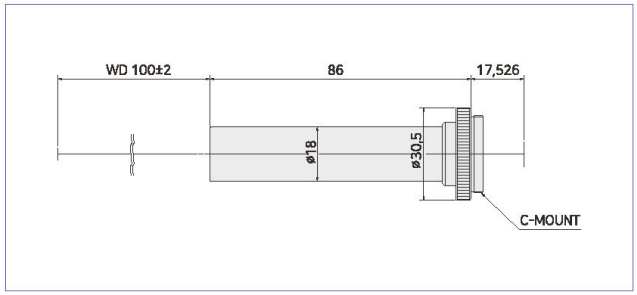
NTL 1.2X-100

Standard & Precision Optics



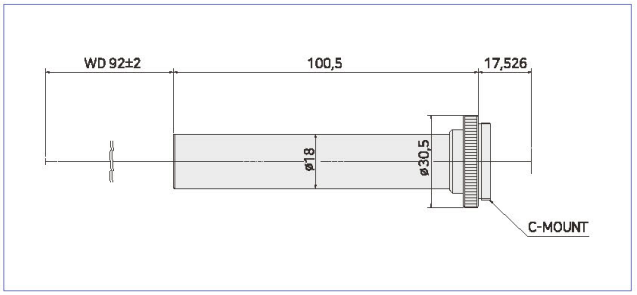
NTL 2.0X-100

Standard & Precision Optics



NTL 4.0X-92

Standard & Precision Optics



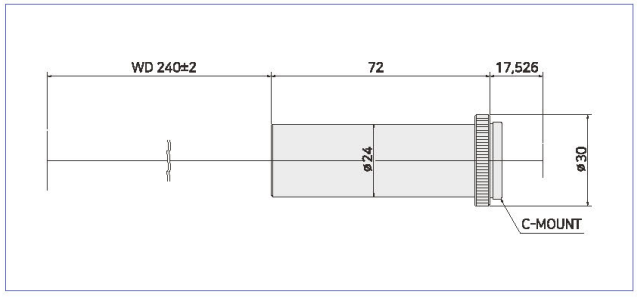
HR Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Optical Distortion (%)	Sensor size	Mount
NTL 0.19X-240-HR	0.19X	240	28	0.012	7.9	8.7	0.13	2/3"(11㎜)	C
NTL 0.198X-185-HR	0.198X	185	21.2	0.0158	6.3	6.4	0.06	1/1.8"(9㎜)	C
NTL 0.3X-240-HR	0.3X	240	17.7	0.019	7.8	3.4	0.135	2/3"(11㎜)	C
NTL 0.57X-200-HR	0.57X	200	11.6	0.029	9.8	1.2	0.04	2/3"(11㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

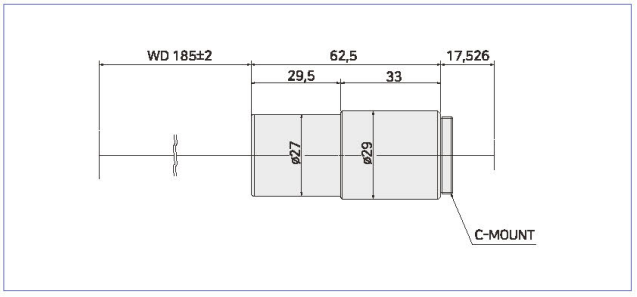
NTL 0.19X-240-HR

Standard & Precision Optics



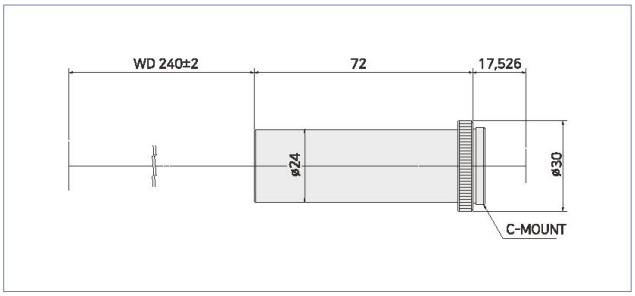
NTL 0.198X-185-HR

Standard & Precision Optics



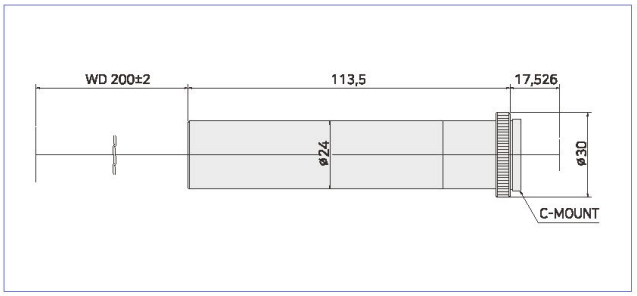
NTL 0.3X-240-HR

Standard & Precision Optics



NTL 0.57X-200-HR

Standard & Precision Optics



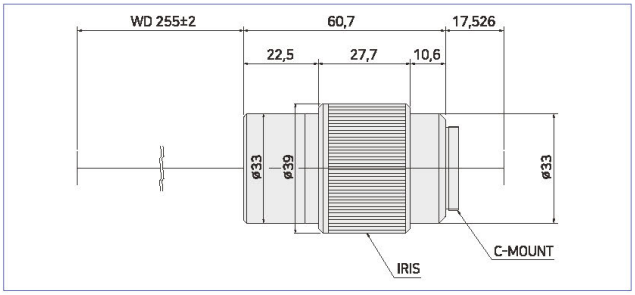
4M Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Optical Distortion (%)	Sensor size	Mount
NTL 0.15X-255I-4M	0.15X	255	29.8	0.0113	6.7	13	0.08	1"(16㎜)	C
NTL 0.185X-225I-4M	0.185X	225	17.6	0.019	4.9	6.2	0.01	1"(16㎜)	C
NTL 0.215X-226I-4M	0.215X	226	20	0.017	6.3	5.9	0.01	1"(16㎜)	C
NTL 0.25X-194I-4M	0.25X	194	14.8	0.023	5.4	3.8	0.01	1"(16㎜)	C
NTL 0.3X-170I-4M	0.3X	170	16.7	0.02	7.5	3.6	0.06	1"(16㎜)	C
NTL 0.47X-176-4M	0.47X	176	10.2	0.033	7.1	1.4	0.28	1"(16㎜)	C
NTL 0.5X-253-4M	0.5X	253	11.2	0.03	8.3	1.4	0.06	1"(16㎜)	C
NTL 0.55X-160-4M	0.55X	160	9.9	0.034	8.1	1.1	0.06	1"(16㎜)	C
NTL 0.75X-160-4M	0.75X	160	8.9	0.0376	10	782㎛	0.06	1"(16㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 22㎛

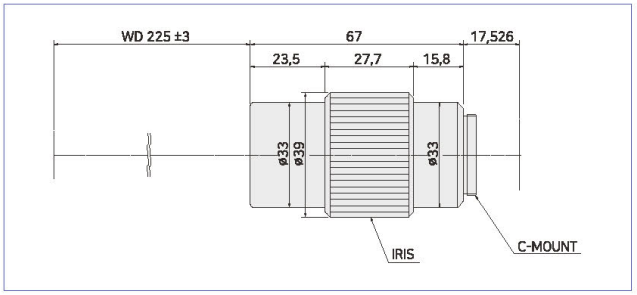
NTL 0.15X-255I-4M

Standard & Precision Optics



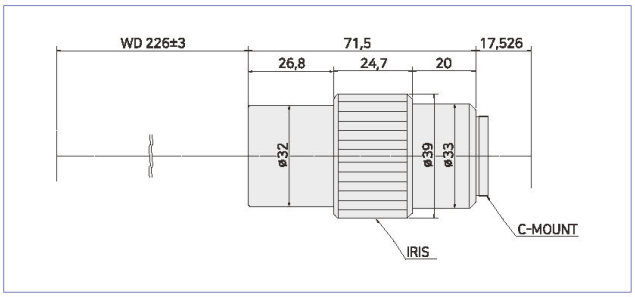
NTL 0.185X-225I-4M

Standard & Precision Optics



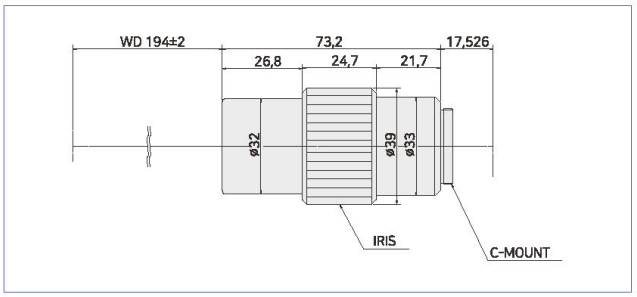
NTL 0.215X-226I-4M

Standard & Precision Optics



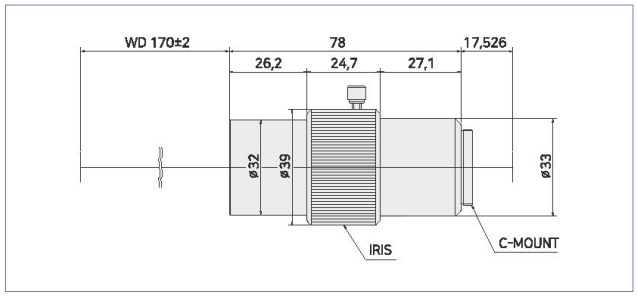
NTL 0.25X-194I-4M

Standard & Precision Optics



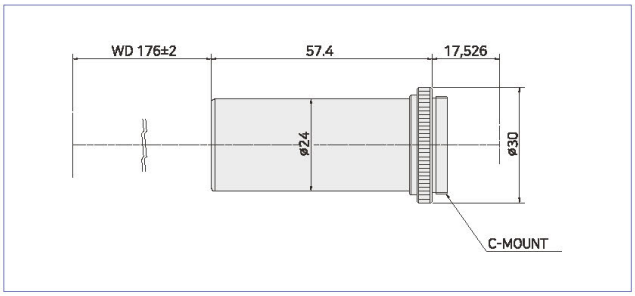
NTL 0.3X-170I-4M

Standard & Precision Optics



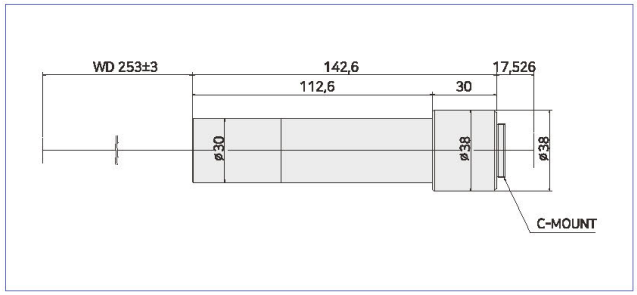
NTL 0.47X-176-4M

Standard & Precision Optics



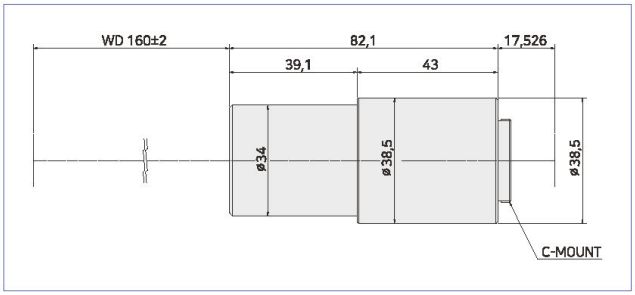
NTL 0.5X-253-4M

Standard & Precision Optics



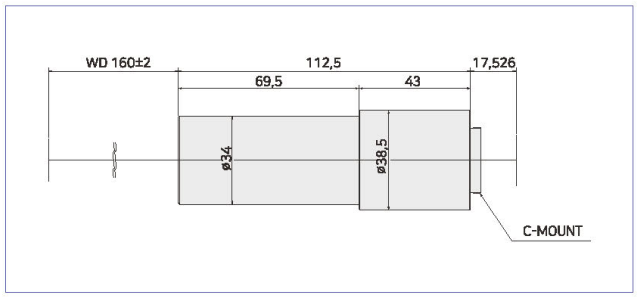
NTL 0.55X-160-4M

Standard & Precision Optics



NTL 0.75X-160-4M

Standard & Precision Optics



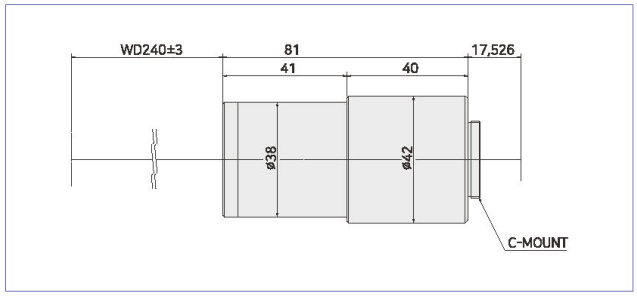
5M Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Optical Distortion (%)	Sensor size	Mount
NTL 0.19X-240-5M	0.19X	240	17.7	0.019	5	3.8	0.03	2/3"(11㎜)	C
NTL 0.257X-185-5M	0.257X	185	16.8	0.02	6.4	2.6	0.01	2/3"(11㎜)	C

* D.O.F Calculation : Permissible of circle of confusion : 13.8㎛

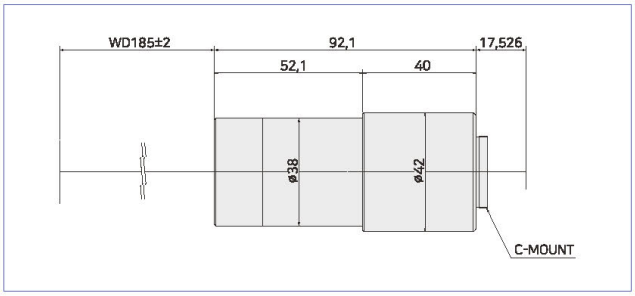
NTL 0.19X-240-5M

Standard & Precision Optics



NTL 0.257X-185-5M

Standard & Precision Optics



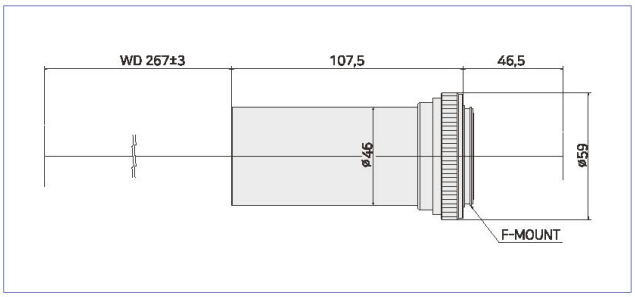
8M Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Optical Distortion (%)	Sensor size	Mount
NTL 0.247X-267-8M	0.247X	267	13.6	0.0247	5	3.6	0.01	8M(23㎜)	F
NTL 0.296X-267-8M	0.296X	267	12	0.028	5.3	2.66	0.01	8M(23㎜)	F
NTL 0.35X-300-8M	0.35X	300	9.6	0.035	5	1.8	0.08	8M(23㎜)	F
NTL 0.37X-261-8M	0.37X	261	9.1	0.037	5	1.6	0.01	8M(23㎜)	F
NTL 0.43X-261-8M	0.43X	261	7.8	0.043	5	1.18	0.01	8M(23㎜)	F
NTL 0.5X-300I-8M	0.5X	300	6.7	0.05	5	880㎛	0.08	8M(23㎜)	F
NTL 0.55X-210-8M	0.55X	210	10.2	0.033	8.3	1.46	0.04	8M(23㎜)	F
NTL 0.63X-310I-8M	0.63X	310	6.9	0.0485	6.5	720㎛	0.08	8M(23㎜)	F
NTL 0.74X-247-8M	0.74X	247	6.5	0.0518	7.1	570㎛	0.06	8M(23㎜)	F
NTL 0.75X-193-8M	0.75X	193	8.9	0.0376	10	782㎛	0.005	8M(23㎜)	F
NTL 0.8X-260I-8M	0.8X	260	5.9	0.0568	7	481㎛	0.05	8M(23㎜)	F

* D.O.F Calculation : Permissible of circle of confusion : 22㎛

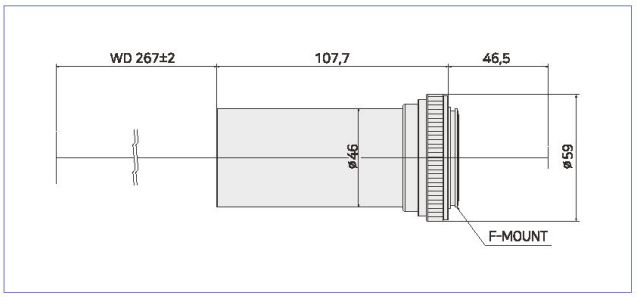
NTL 0.247X-267-8M

Standard & Precision Optics



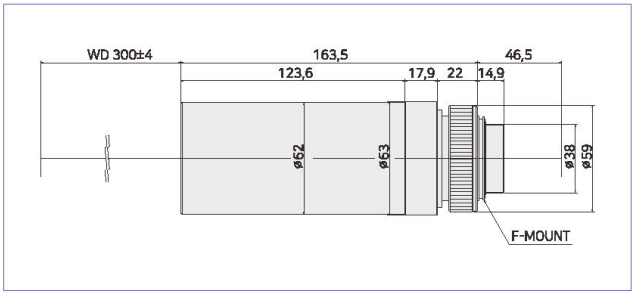
NTL 0.296X-267-8M

Standard & Precision Optics



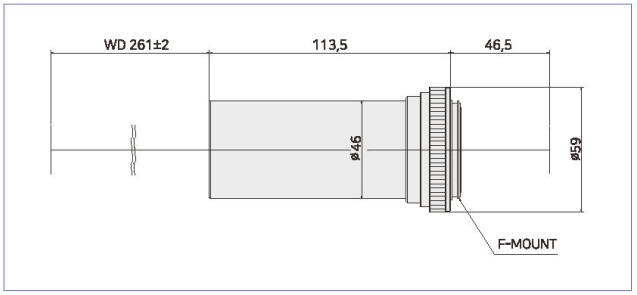
NTL 0.35X-300-8M

Standard & Precision Optics



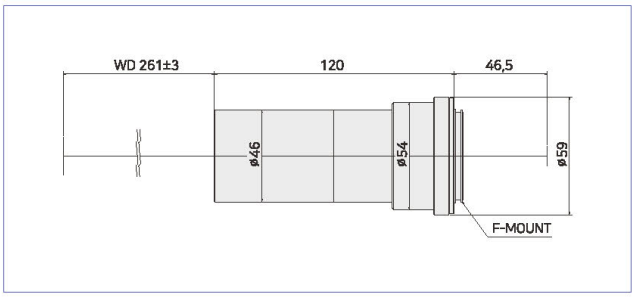
NTL 0.37X-261-8M

Standard & Precision Optics



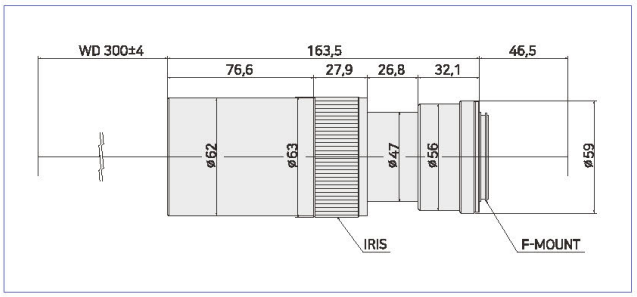
NTL 0.43X-261-8M

Standard & Precision Optics



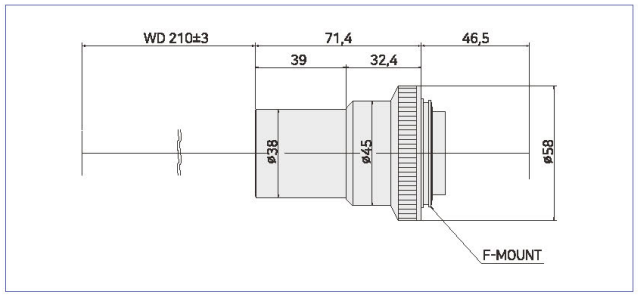
NTL 0.5X-300I-8M

Standard & Precision Optics



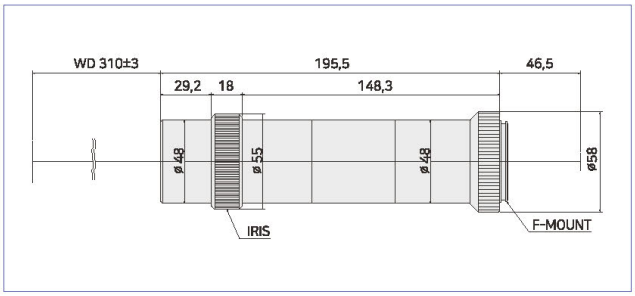
NTL 0.55X-210-8M

Standard & Precision Optics



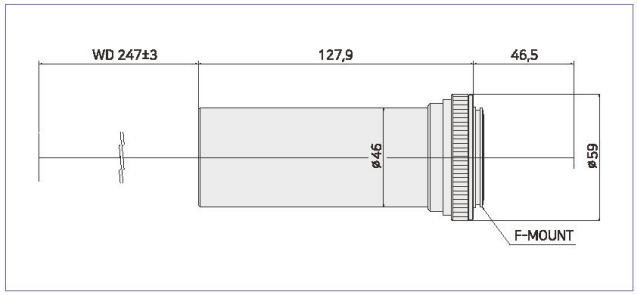
NTL 0.63X-310I-8M

Standard & Precision Optics



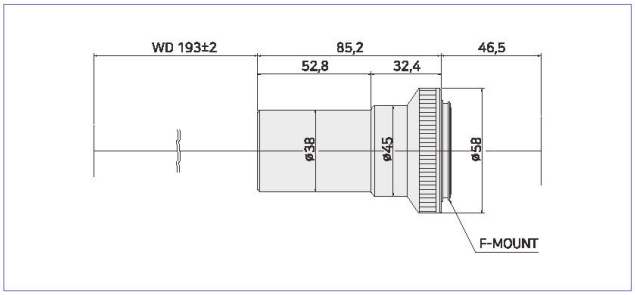
NTL 0.74X-247-8M

Standard & Precision Optics



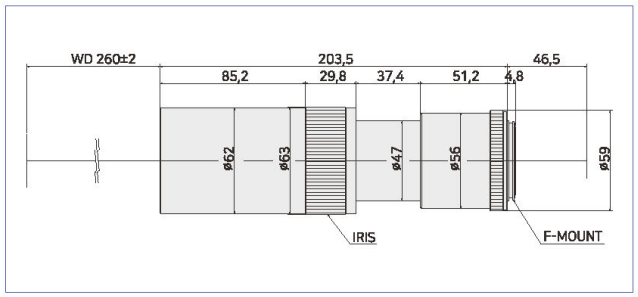
NTL 0.75X-193-8M

Standard & Precision Optics



NTL 0.8X-260I-8M

Standard & Precision Optics



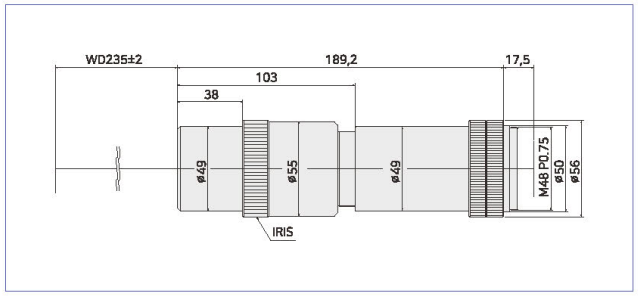
12M Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Optical Distortion (%)	Sensor size	Mount
NTL 0.54X-235I-12M	0.54X	235X	7.8	0.043	6.3	1.3	0.05	12M(28㎜)	M48

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

NTL 0.54X-235I-12M

Standard & Precision Optics



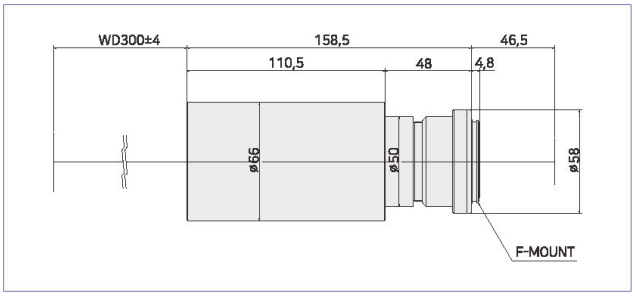
15M Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Optical Distortion (%)	Sensor size	Mount
NTL 0.42X-300-15M	0.42X	300	8.6	0.039	5.4	1.2	0.08	15M(25㎜)	F
NTL 0.789X-260-15M	0.789X	260	6	0.056	7	674㎛	0.06	15M(25㎜)	F

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

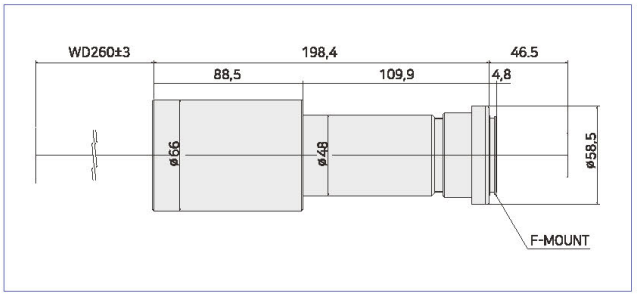
NTL 0.42X-300-15M

Standard & Precision Optics



NTL 0.789X-260-15M

Standard & Precision Optics



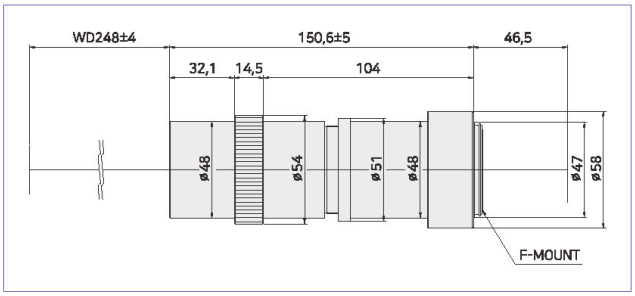
25M Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎜)	Optical Distortion (%)	Sensor size	Mount
NTL 0.52X-248I-25M	0.52X	248	7.8	0.043	6	799㎛	0.05	25M(32㎜)	F

* D.O.F Calculation : Permissible of circle of confusion : 20㎛

NTL 0.52X-248I-25M

Standard & Precision Optics



NTL-LINE Series

FEATURES

- Can support up to 12K(5㎛/pixel) that is 62.4㎜ diagonal length.
- High resolution & high contrast optical design.
- Nearly zero distortion design for whole F.O.V.
- Various magnification from 0.5X to 3.5X.
- Fine focus function is adapted without change of own W.D.

NTL Line Series not only compatible with 4K, 8K line sensor cameras but change the mount for any flange-back length. It can be applied for measurement of FPD(defect & particle, ink injection), Lead Frame(tap, film), LED components(housing and package) application. This series have designed of high resolution & high contrast with low distortion for excellent image.

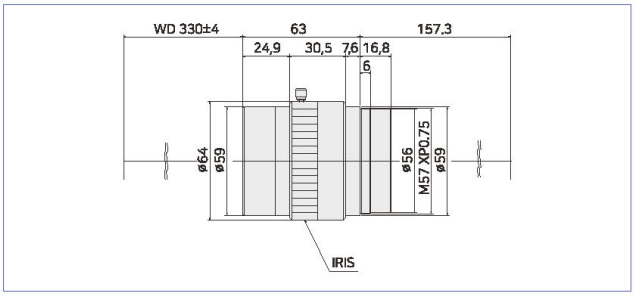
NTL-Line Series

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Optical Distortion(%)	Sensor size	Mount
NTL 0.5X-330I-12K	0.5X	330	8.6	0.039	6.4	512	0.08	12K(5㎛)	M72
NTL 0.7X-257I-12K	0.7X	257	9.6	0.035	10	408	0.01	12K(5㎛)	M72
NTL 1.0X-202I-12K	1.0X	202	6.7	0.05	10	200	0.04	12K(5㎛)	M72
NTL 1.4X-168I-12K	1.4X	168	5.3	0.063	11.1	113	0.02	12K(5㎛)	M72
NTL 2.0X-50I-12K	2.0X	50	3	0.11	9.1	45	0.03	12K(5㎛)	M72
NTL 2.0X-140I-12K	2.0X	140	4.3	0.078	12.8	64	0.03	12K(5㎛)	M72
NTL 3.5X-88I-12K	3.5X	88	2.4	0.14	12.5	20	0.05	12K(5㎛)	M72

* Remark : Possible to change for mount

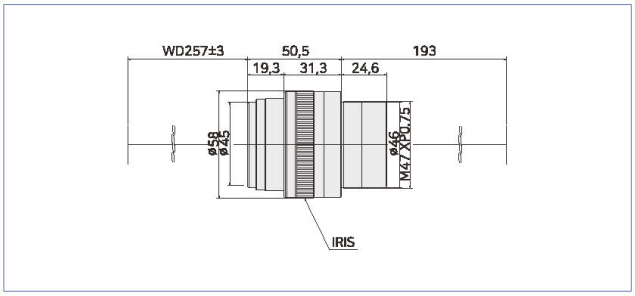
NTL 0.5X-330I-12K

Standard & Precision Optics



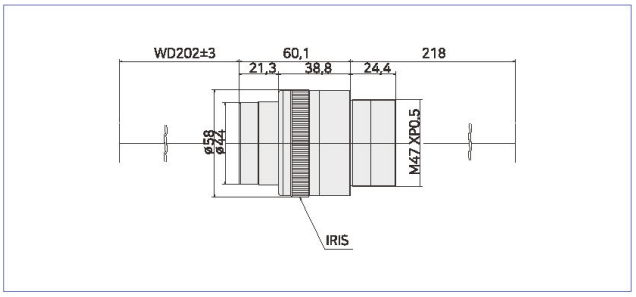
NTL 0.7X-257I-12K

Standard & Precision Optics



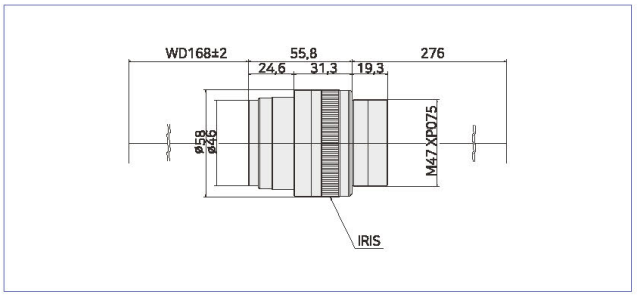
NTL 1.0X-202I-12K

Standard & Precision Optics



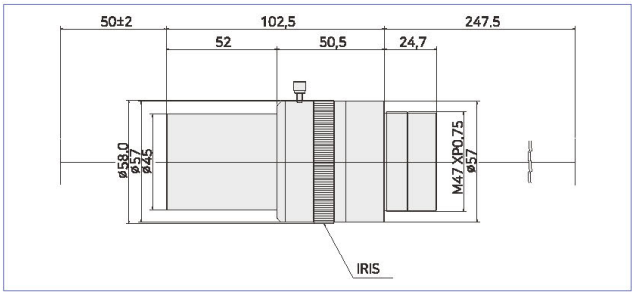
NTL 1.4X-168I-12K

Standard & Precision Optics



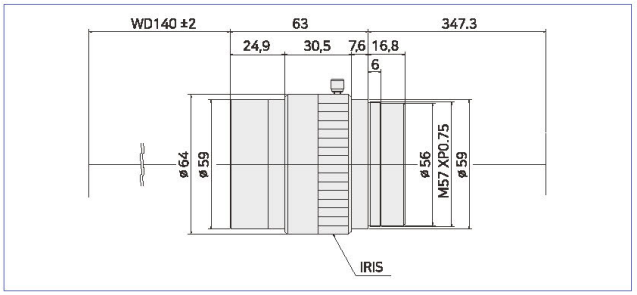
NTL 2.0X-50I-12K

Standard & Precision Optics



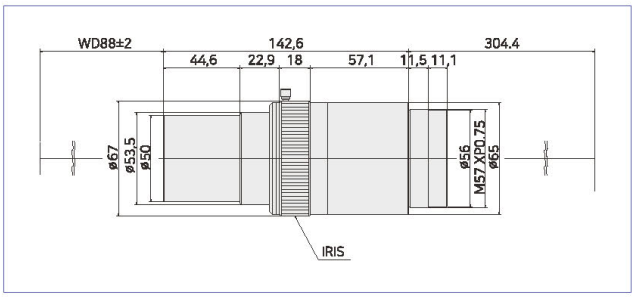
NTL 2.0X-140I-12K

Standard & Precision Optics



NTL 3.5X-88I-12K

Standard & Precision Optics

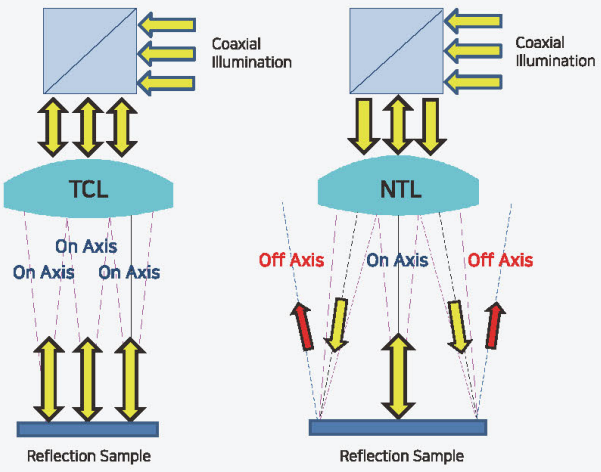


TIP Standard & Precision Optics

Q. What is the reason that is difficult to make coaxial illumination for Non-telecentric lens?

A. There is no viewing angle in case of telecentric lens. Thus reflected light from object will enter to the lens perfectly(On-Axis for optical axis).
It means that principal ray is parallel to the optical axis of lens. Finally, it can make uniform image for whole F.O.V.

Besides, Non-telecentric lens can't get the whole reflection light from object due to viewing angle for optical axis so there is loss the reflected light(Off axis for optical axis).



Zoom Lens Series

ZNTL 0515 / ZNTL 0530

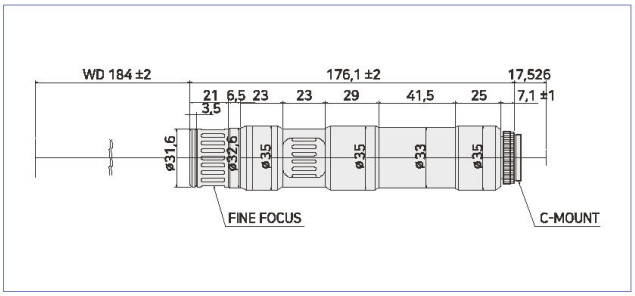
This zoom lens has high resolution to get the high contrast image
compared to the general zoom lens.
There are 2 types of zoom lenses accosting to magnification those are 0.5X~1.5X & 0.5X~3.0X.
It can support up to ½"(8㎜ diagonal length) camera sensor.
These zoon lenses are manual zoom function also have fine focus adjustment without change the own W.D.
It is good for the inspection those are LED die bonding and wire bonding application.

ZNTL 0515

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Optical Distortion (%)	Sensor size	Mount
ZNTL 0515	0.5X	184	11.2	0.0298	8.3	2.6㎜	0.2	1/2"	C
	1.5X	184	6.7	0.05	15	533	0.15	1/2"	C

ZNTL 0515

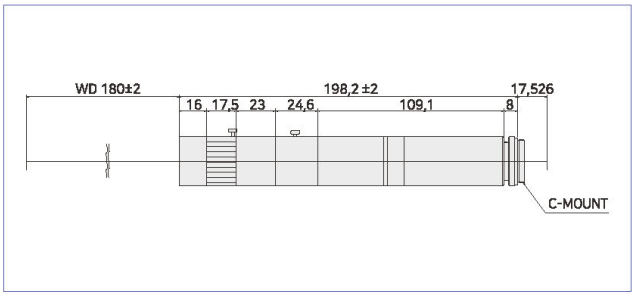
Standard & Precision Optics



ZNTL 0530

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Optical Distortion (%)	Sensor size	Mount
ZNTL 0530-1/2	0.5X	180	21	0.016	15.6	5㎜	0.6	1/2"	C
	3.0X	180	7.8	0.043	34.9	310	0.2	1/2"	C
ZNTL 0530-1/3	0.5X	180	18.6	0.018	13.9	4.4㎜	0.25	1/3"	C
	3.0X	180	7	0.048	31.3	278	0.14	1/3"	C

ZNTL 0530

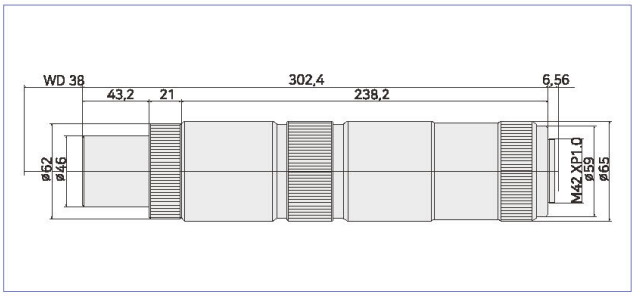


ZNTL 3050

This zoom lens have designed for large camera sensor for 2K line camera, 4M camera, etc.
It can support up to 26㎜ diagonal length and low distortion for over full range of magnification.

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Optical Distortion (%)	Sensor size	Mount
ZNTL 3050	3.0X	38	3.6	0.093	16.1	93.6	0.046	2K(13u)	M42
	4.0X	38	2.9	0.115	17.4	56.5	0.032	2K(13u)	M42
	5.1X	38	2.6	0.13	19.6	39.1	0.044	2K(13u)	M42

ZNTL 3050



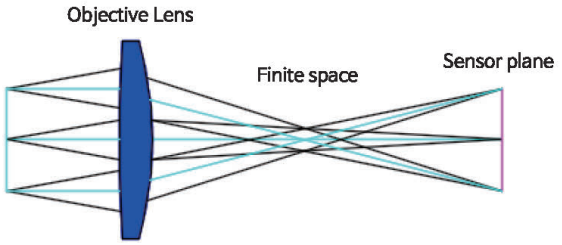
CMM Series

FEATURES

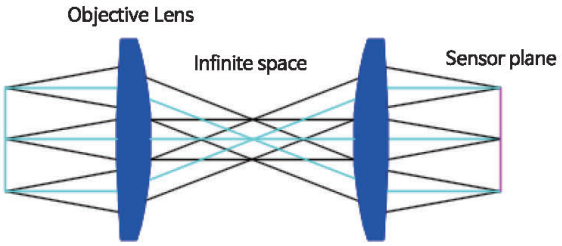
- Compact size unit.
- Same image quality like real microscope system.
- Compatible with any CF Plan and EPI objectives.
- Possible to insert the optical components.

INFINITY CORRECTED OPTICAL SYSTEM

Infinity corrected optical systems are used in research laboratory microscopes and industrial metallurgical microscopes generally.
This microscope system have an image distance is set to infinity.
This means that a tube lens is placed between the tube barrel and the objective to produce final image.
The Infinity optical system is possible to insert optical components(such as illuminators, polarizers, filter, etc.) to be added into the parallel optical path between the objective and the tube lens with only a minimal effect on focus position.
The tube length in infinity corrected optical systems ranges from 160 to 200㎜ which is known as the focal length according to the manufacturer.



[Finite Optical System]



[Infinite Optical System]

One feature for using infinity corrected optics is that parfocality between different objectives can still be maintained, even when one or more auxiliary components(such as illuminators or polarizers) are added into the optical path. Another feature is that accessories can be created to produce exactly 1x magnification without altering the alignment between the objective and tube lens.

SPO have named this system that is CMM Series(Compact Microscope Module).
It is good for the production fields to give online monitoring inspection without any loss image quality. It is compact microscope unit for monitoring system which can apply to inline machine vision application. It is compatible with any CF Plan & EPI objective lenses(Bright Field).

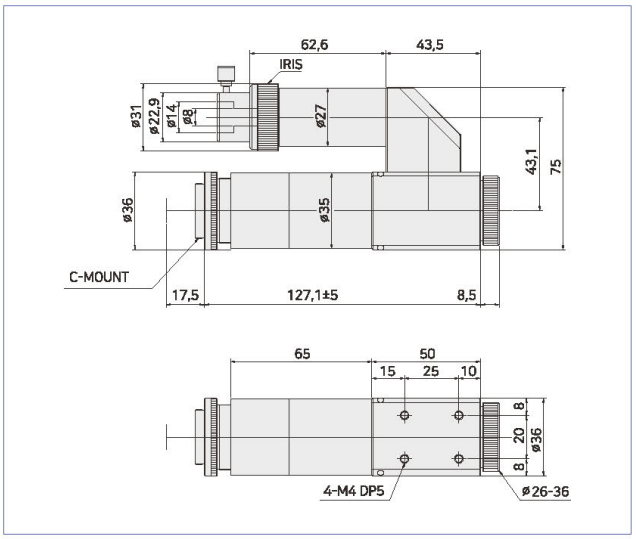
It is also applied for the Koehler illumination optics for uniform intensity over the whole image. There are various types CMM series according to camera sensor size like 2/3", 4M, 8M.
It is possible to change the mount to C-mount in case of CMM-8M also compatible with 4M(1").

CMM Series

Model	EFL of Tube Lens	Magnification of Tube Lens	Illumination Method	Sensor size	Mount
CMM 0.5X-Iris	100㎜	0.5X	Koehler Illumination	2/3"(11㎜)	C
CMM 1.0X-Iris	200㎜	1.0X	Koehler Illumination	2/3"(11㎜)	C
CMM 1.5X-Iris	300㎜	1.5X	Koehler Illumination	1/2"(8㎜)	C
CMM 2.0X-Iris	400㎜	2.0X	Koehler Illumination	1/2"(8㎜)	C

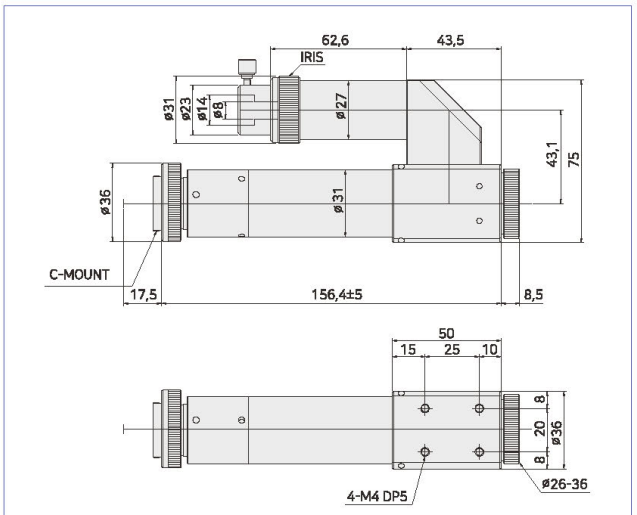
CMM 0.5X-Iris

Standard & Precision Optics



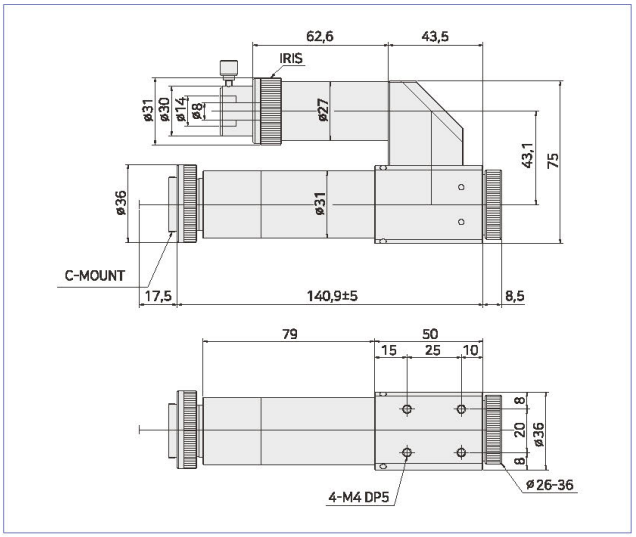
CMM 1.0X-Iris

Standard & Precision Optics



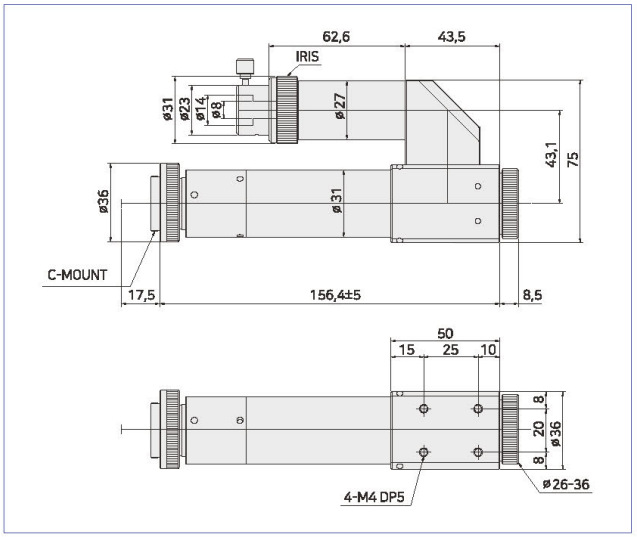
CMM 1.5X-Iris

Standard & Precision Optics



CMM 2.0X-Iris

Standard & Precision Optics

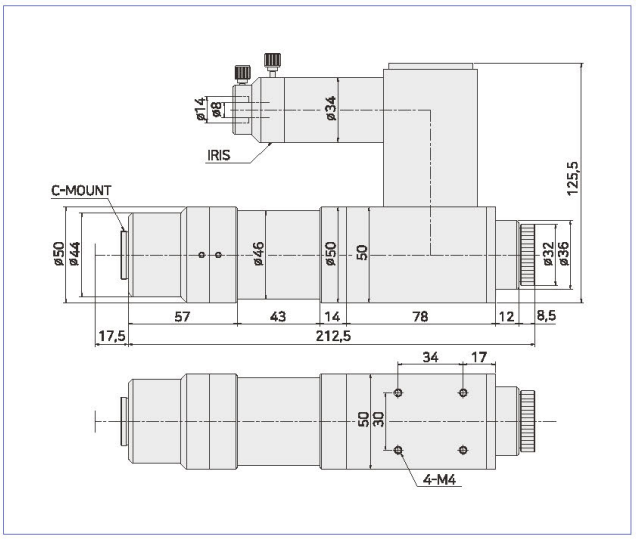


CMM-4M Series

Model	EFL of Tube Lens	Magnification of Tube Lens	Illumination Method	Sensor size	Mount
CMM 0.75X-4M	150㎜	0.75X	Koehler Illumination	1"(16㎜)	C
CMM 1.0X-4M	200㎜	1.0X	Koehler Illumination	1"(16㎜)	C
CMM 1.25X-4M	250㎜	1.25X	Koehler Illumination	1"(16㎜)	C
CMM 1.5X-4M	300㎜	1.5X	Koehler Illumination	1"(16㎜)	C

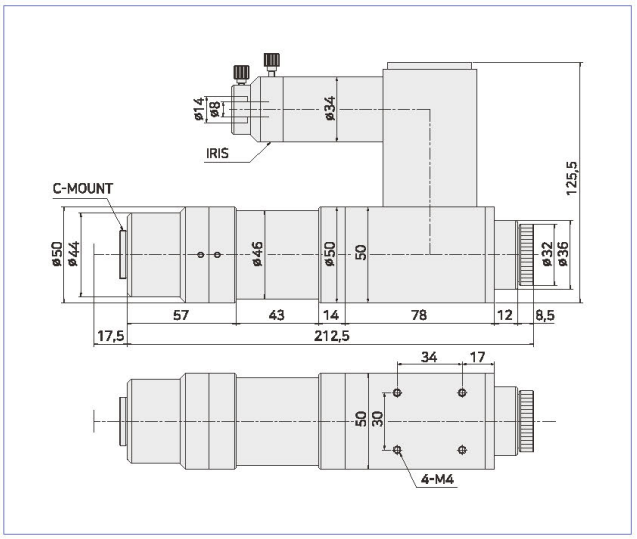
CMM 0.75X-4M

Standard & Precision Optics



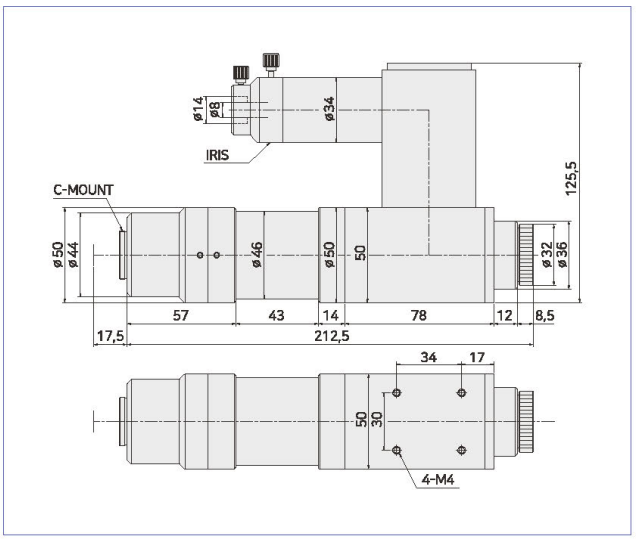
CMM 1.0X-4M

Standard & Precision Optics



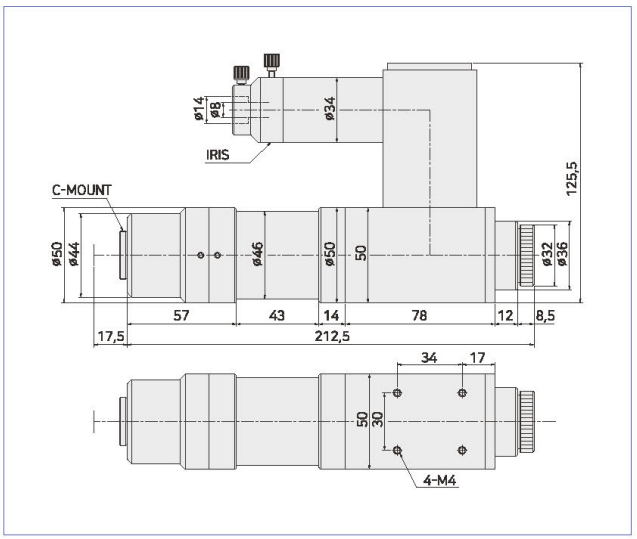
CMM 1.25X-4M

Standard & Precision Optics



CMM 1.5X-4M

Standard & Precision Optics

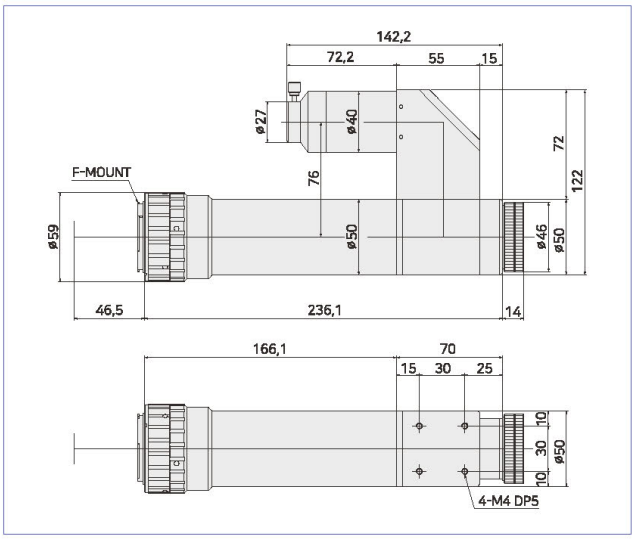


CMM-8M Series

Model	EFL of Tube Lens	Magnification of Tube Lens	Illumination Method	Sensor size	Mount
CMM 1.0X-8M	200㎜	1.0X	Koehler Illumination	8M(23㎜)	F
CMM 1.2X-8M	240㎜	1.2X	Koehler Illumination	8M(23㎜)	F
CMM 2.5X-8M	500㎜	2.5X	Koehler Illumination	8M(23㎜)	F
CMM 4.0X-8M	800㎜	4.0X	Koehler Illumination	8M(23㎜)	F

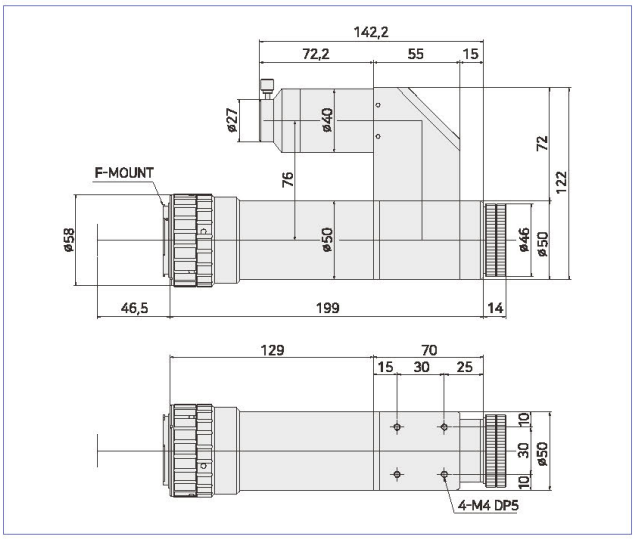
CMM 1.0X-8M

Standard & Precision Optics



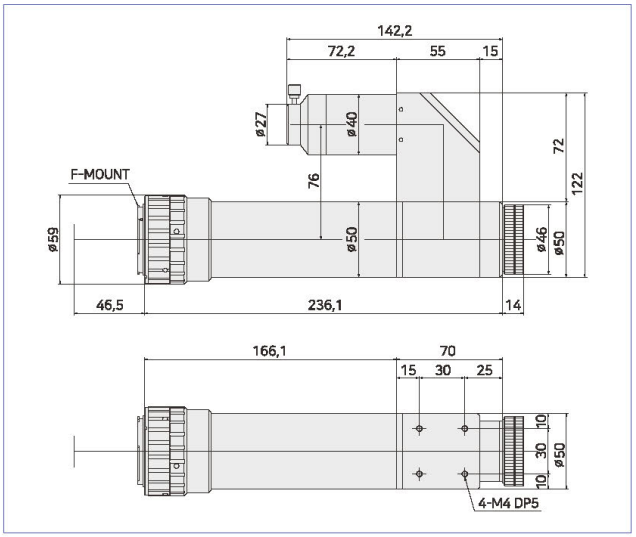
CMM 1.2X-8M

Standard & Precision Optics



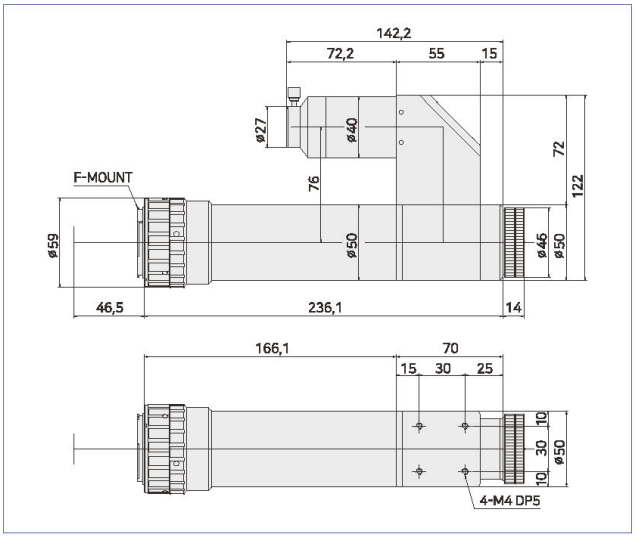
CMM 2.5X-8M

Standard & Precision Optics



CMM 4.0X-8M

Standard & Precision Optics

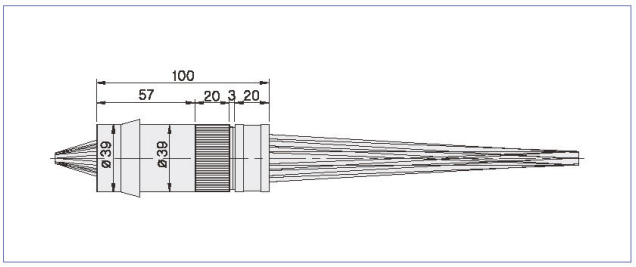


Parfocal Series

Model	EFL of Tube Lens	Magnification of Tube Lens	Illumination Method	Sensor size
Parfocal Tube 0.26X	52mm	0.26X	-	1/3"
Parfocal Tube 0.33X	66mm	0.33X	-	1/2"
Parfocal Tube 0.4X	80mm	0.4X	-	1/2"
Parfocal Tube 0.5X	100mm	0.5X	-	1/2"
Parfocal Tube 0.75X	150mm	0.75X	-	1/2"
Parfocal Tube 1.0X	200mm	1.0X	-	1/2"
Parfocal Tube 1.5X	300mm	1.5X	-	1/2"
Parfocal Tube 2.0X	400mm	2.0X	-	1/2"

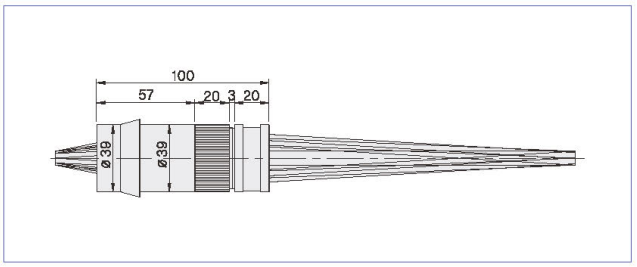
Parfocal Tube 0.26X

Standard & Precision Optics



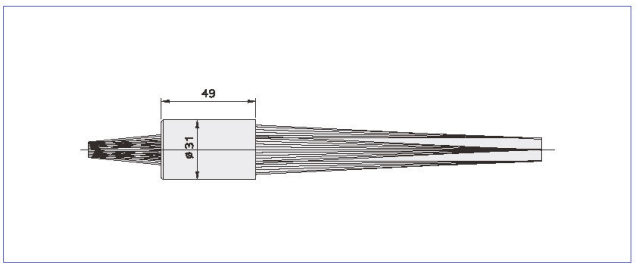
Parfocal Tube 0.33X

Standard & Precision Optics



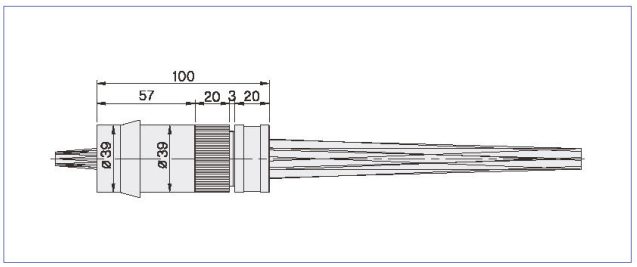
Parfocal Tube 0.4X

Standard & Precision Optics



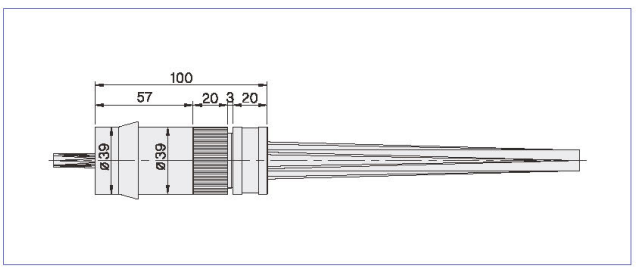
Parfocal Tube 0.5X

Standard & Precision Optics



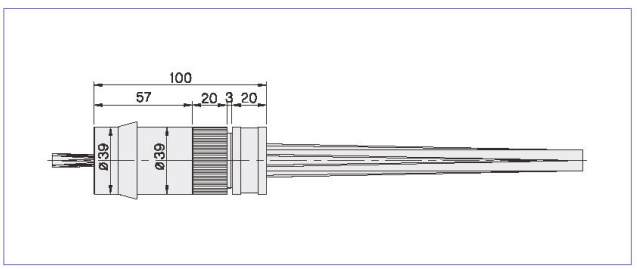
Parfocal Tube 0.75X

Standard & Precision Optics



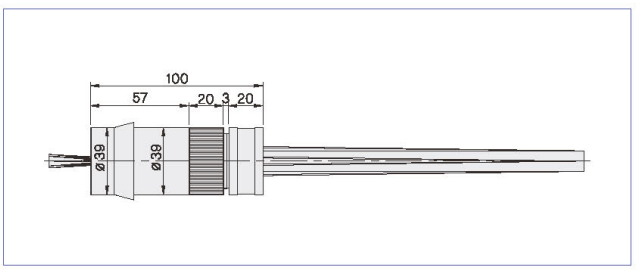
Parfocal Tube 1.0X

Standard & Precision Optics



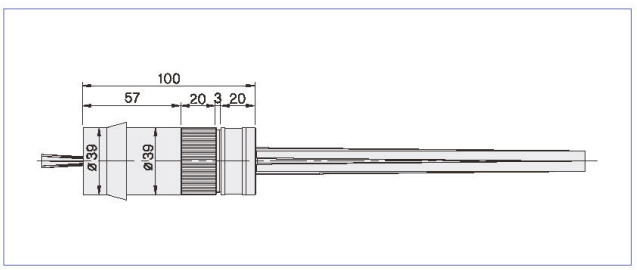
Parfocal Tube 1.5X

Standard & Precision Optics



Parfocal Tube 2.0X

Standard & Precision Optics



Standard & Precision Optics

Objective Lens

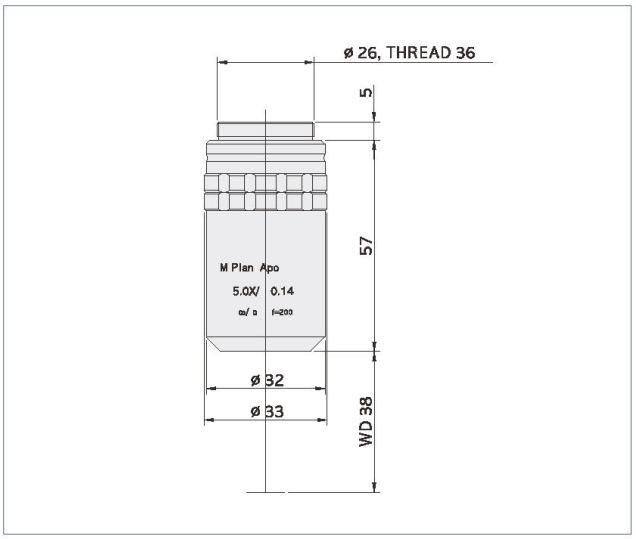
- The infinity-correction objective lens is the main part of the microscope.
- This lens has a long working distance and high N.A. parfocal length.
- Magnification : 5.0X

Objective Lens

Model	EFL of Tube Lens	Magnification of Tube Lens	Illumination Method	Sensor size	Mount	F.O.V (24㎜ dia, eyepiece)
MI 5.0X	5.0X	38	0.14	14	40	4.8㎜ dia

MI 5.0X

Standard & Precision Optics

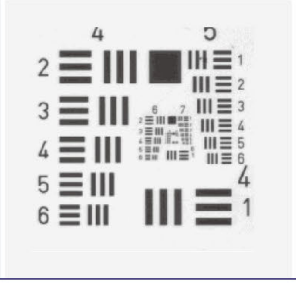
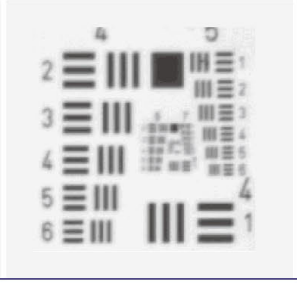
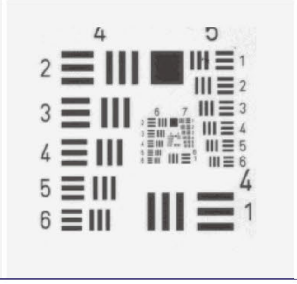
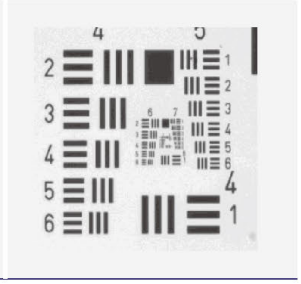


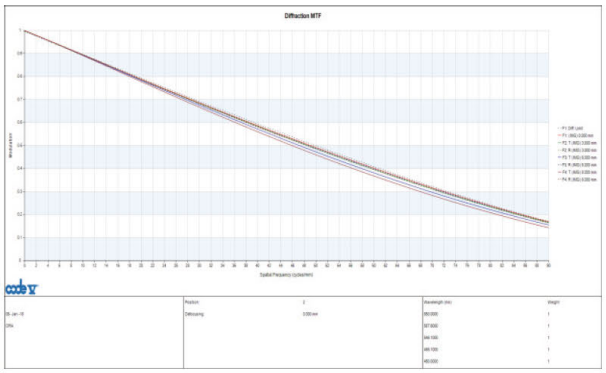
Telecentric Lens with Polymer Lens

Generally, in case of telcentric lens has the fixed W.D for certain magnification different with conventional lens.
When W.D should be changed due to measuring of height specimen, There is limitation that can't cover D.O.F is not enough.
Finally, there is limitation to get the clear image simultaneously against to various height for one specimen.

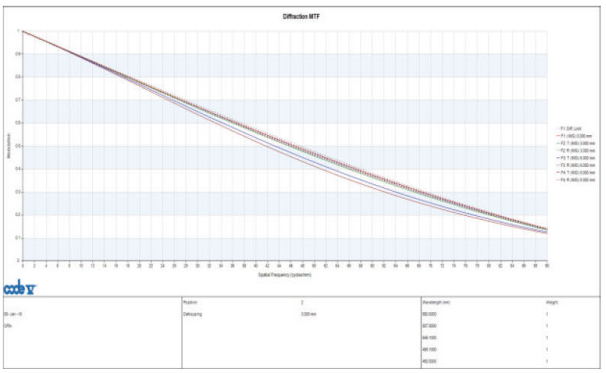
However, this system has developed to overcome this kind of limitation with combination of polymer lens(tunable lens).
There are no added vignetting, no distortion, no loss of resolution.
Even if there is magnification change, it can be compensated via software

It is good for packet sorting, Barcode reading and bottles, LCD inspection according to height object simultaneously.
It is compact design and easy to install the system for customer's demand.

	TCL 2.0X-110D-4M		TCL 2.0X-110D-4M-PYL	
W.D	110㎜	112.9㎜	110㎜	112.9㎜
Focus image				



Mag : 2.06X. W.D : 110.9㎜



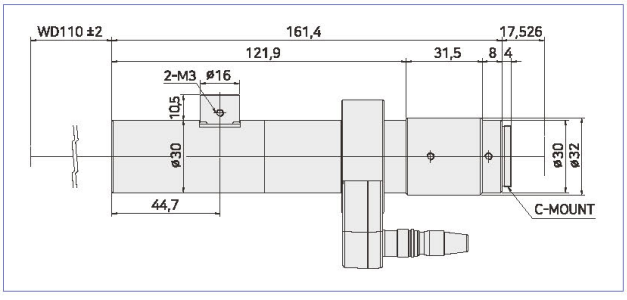
Mag : 2.12X. W.D : 112.9㎜

Standard & Precision Optics

Optical Specification

TCL 2.0X-110D-4M-PYL

- Mag : 2.0X(1.79X~2.12X)
- W.D : 110㎜(110.9~112.9)
- Resolution : 4.8㎛
- N.A : 0.07
- F/# : 14.28~15.14
- D.O.F : 157㎛



Laser Optics

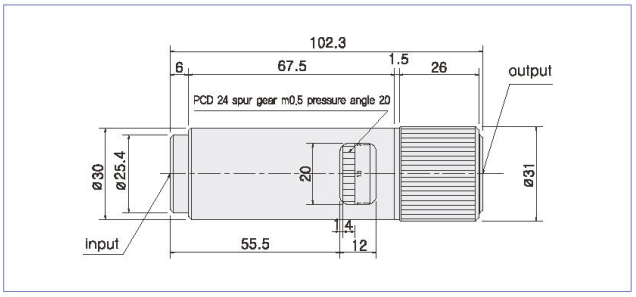
Zoom BET

Laser beam expander is used in laser marking system to get good marking quality.
We have 4 types of beam expander like below.

- Zoom beam expander for 1064㎚ & 355㎚ laser.
- Zoom ratio : 1~2.5X
- Focusing ring adapted for adjusting the divergence angle of laser.
- Motorizing possible at user side.

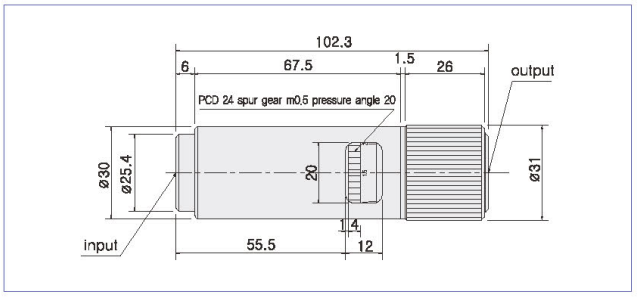
Zoom BET 355㎚

Standard & Precision Optics



Zoom BET 1064㎚

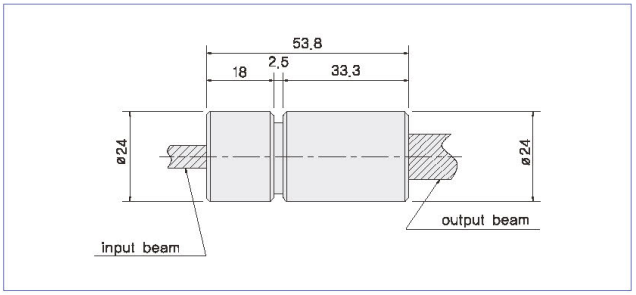
Standard & Precision Optics



Manual Beam Expander for 1064㎚ Wavelength

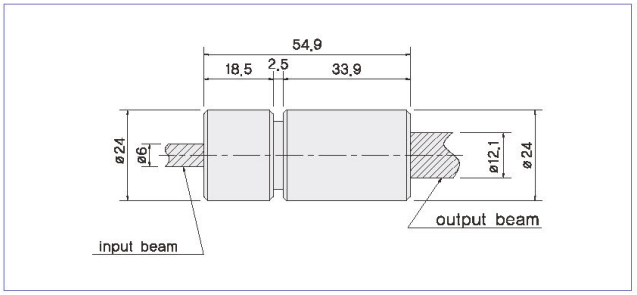
BET 1.5X-1064

Standard & Precision Optics



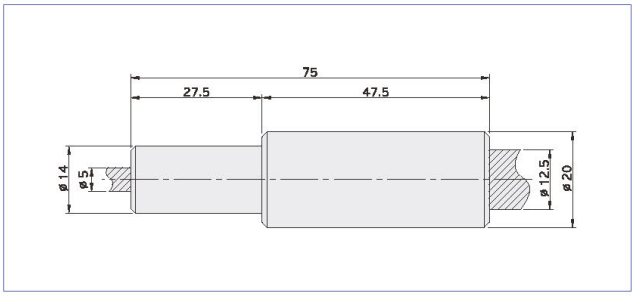
BET 2.0X-1064

Standard & Precision Optics



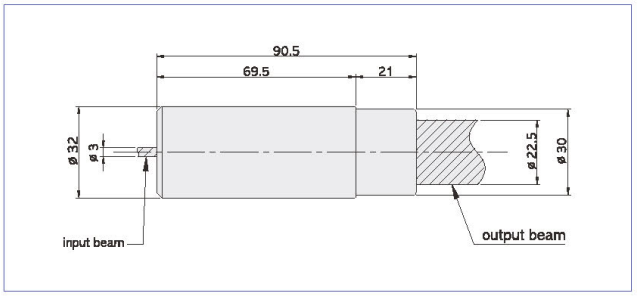
BET 2.5X-1064

Standard & Precision Optics



BET 7.0X-1064

Standard & Precision Optics



LED Controller

Analog LED Controller

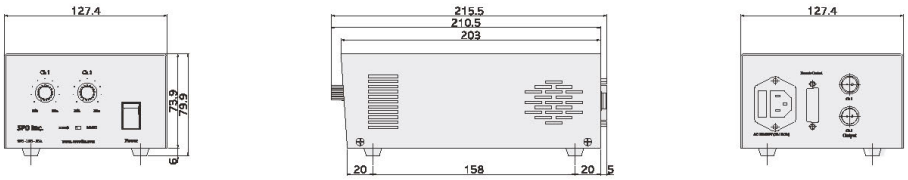
It can control the LED guide which is commonly used in the machine vision.
It is constant current control type instead of voltage control which is stable for current.

- Basic channel : 2 to 9 channels.
- Constant current control type optimized for LED lamp.
- External 0~5V to control the volume
- Easy to control the intensity by front of volume knob.
- On/Off control by DC voltage(Ex : Off@5V).

Model	Channel	Output (Max.)	Volume Control	Input Voltage	Remote control Connector
SPO-LED-2CA	2	1A&3V or 12V(Max:24W)	Volume control by front knob	AC100~240V(50/60Hz)	D-sub. 15pin(male)
SPO-LED-4CA	4	1A&3V or 12V(Max:50W)	Volume control by front knob	AC100~240V(50/60Hz)	D-sub. 15pin(male)
SPO-LED-9CA	9	5A&40V(Max:500W)	Volume control by front knob	AC 220V±15%	D-sub. 25pin(male)

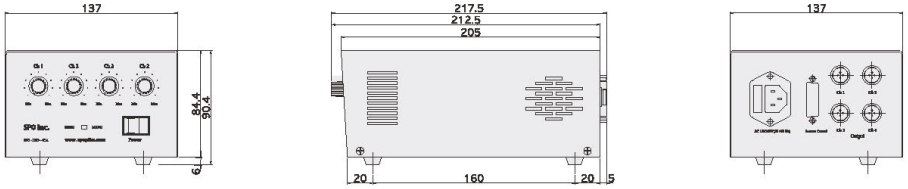
SPO-LED-2CA

Standard & Precision Optics



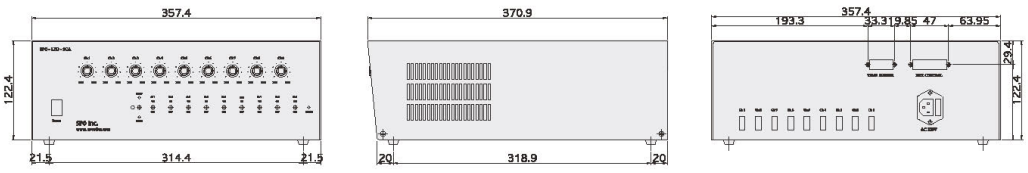
SPO-LED-4CA

Standard & Precision Optics



SPO-LED-9CA

Standard & Precision Optics



Digital LED Controller

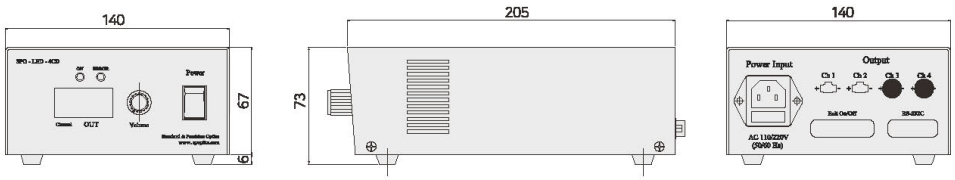
This controller is digital control type instead of analog via RS-232 communication to give customers convenient.

- Basic channel : 2 to 8 channels.
- Constant current control type optimized for LED lamp.
- RS-232 communication control for volume.
- Easy to control the intensity by front of Jog.
- I/O control for On/Off function.
- Volume display on the front panel of controller.

Model	Channel	Output (Max.)	Volume Control	Input Voltage	Ext. control Connector
SPO-LED-2CD	2	2A&3V or 12V(Max:65W)	0~255 Level by Jog Dial	AC100~240V(50/60Hz)	RS-232, D-sub. 15pin(male)
SPO-LED-4CD	4	2A&3V or 12V(Max:65W)	0~255 Level by Jog Dial	AC100~240V(50/60Hz)	RS-232, D-sub. 15pin(male)
SPO-LED-8CD	8	1A&3V or 12V(Max:100W)	0~255 Level by Jog Dial	AC 220V±15%	RS-232, D-sub. 15pin(male)

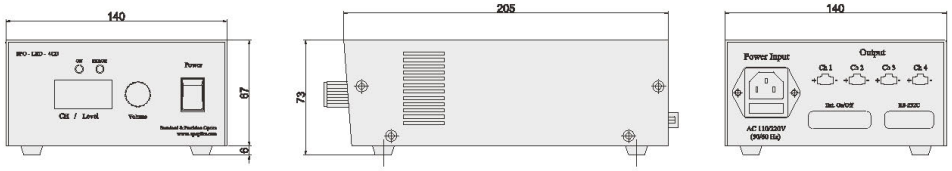
SPO-LED-2CD

Standard & Precision Optics



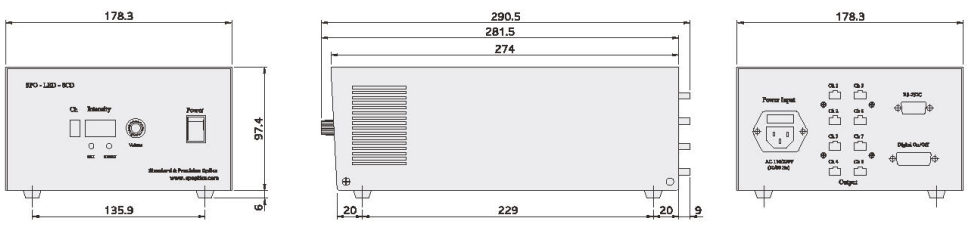
SPO-LED-4CD

Standard & Precision Optics



SPO-LED-8CD

Standard & Precision Optics



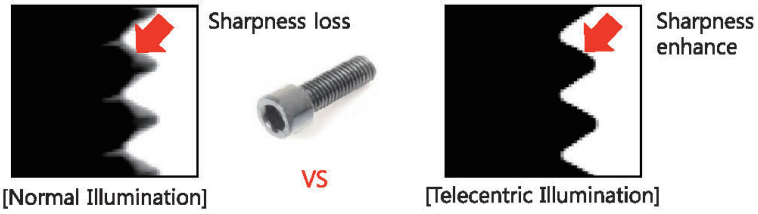
LED Illumination

Telecentric Illumination

FEATURES

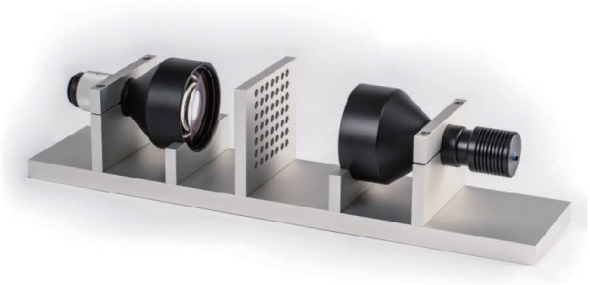
- High quality telecentric illumination.
- High edge contrast for accuracy measurement.
- High telecentricity improvement.
- Easy to adapt of SPO's telecentric lens.
- Easy to replacement for LED module.

This illumination is good for the high accuracy measurement for edge shape or hole size those are bolt pitch, angle, coils, prings, etc... It is extremely recommended to adapt the telecentric lens to improve the image quality for clear shaped image by eliminating of scattering image.

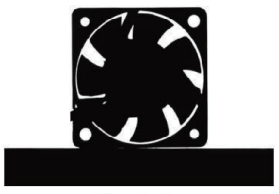


[Normal Illumination] [Telecentric Illumination]

It can be increased edge contrast and measurement accuracy definitely by reducing diffuse reflections.
Thus there is no sharpness loss where can measure more precisely than general backlight illumination.
It will be good match for the telecentric lens for accurate measurement.
Also easy to analyze of image shape for accurate measuring the object also possible to customize and apply for various magnifications and color in the field.



Installation for Telecentric system



Electric Fan

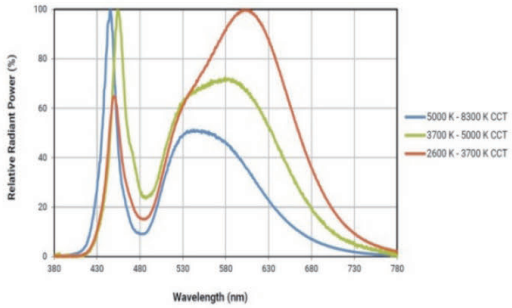
LED Guide Housing

Choice for LED Color

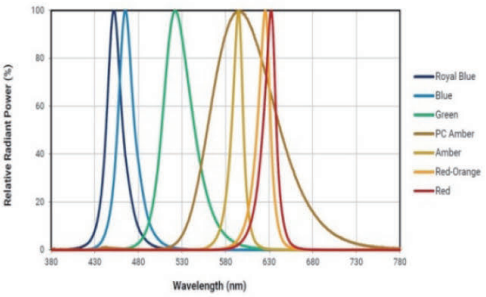
Model	Color / Wavelength	Device Power (W)	Forward Voltage (V)	Forward Current (mA)	DC Voltage (V)
TIL-xx-R	RED / 625nm	< 2	3.2	350	12/24
TIL-xx-G	Green / 530nm	< 2	3.2	350	12/24
TIL-xx-B	Blue / 470nm	< 2	3.2	350	12/24
TIL-xx-W	White / 5700K~6500K(CCT)	< 2	3.2	350	12/24

* "xx" means diameter

It is possible to customize for different colors according to customer's requirement.



White LED Spectrum



LED Spectrum for color

Standard & Precision Optics

LED Driver Usage

Driver

1. Open the circle cover to control intensity
2. Adjust intensity by "-" type driver
   ▸ Initial version have set 180mA(Max.380mA)
3. Can control the intensity of LED

Cable

1. Brown : 12~24V
2. Black : GND
3. Blue : Bypass(Max.350mA) ▸ Direct LED control by another drive
4. 2 Pin connector with LED Module

Telecentric Illumination

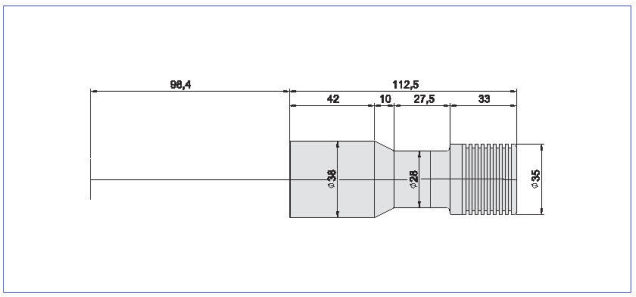
Model	Beam Diameter (mm)	Out Diameter (mm)	W.D (mm)	Length (mm)	Color
TIL-20-x	20	38	98.4±20	112.5	W/R/G/B
TIL-50-x	50	78	92.5±25	157.5	W/R/G/B
TIL-76-x	76	94	108.7±30	167.5	W/R/G/B
TIL-80-x	80	97	178±50	230.7	W/R/G/B
TIL-180-x	180	204	400±100	471	W/R/G/B

* "x" means LED color

SPO can make different beam diameter telecentric illumination if you need.
Please, contact to us whenever you need special one.

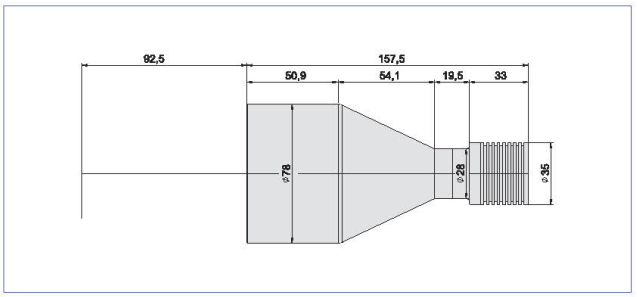
TIL-20-x

Standard & Precision Optics



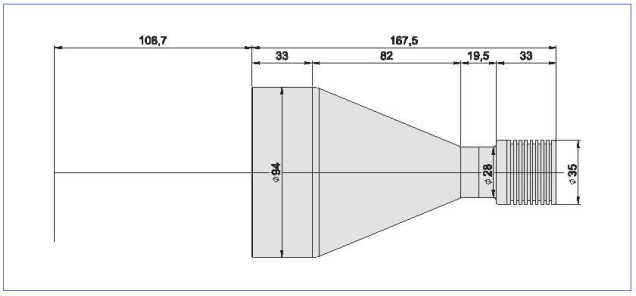
TIL-50-x

Standard & Precision Optics



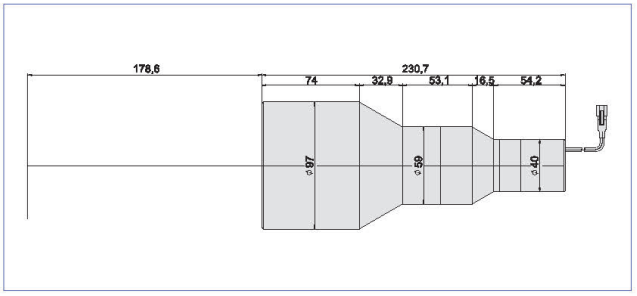
TIL-76-x

Standard & Precision Optics



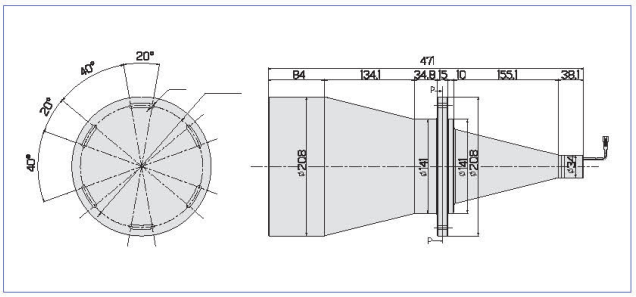
TIL-80-x

Standard & Precision Optics



TIL-180-x

Standard & Precision Optics



Coaxial Illumination LED Guide

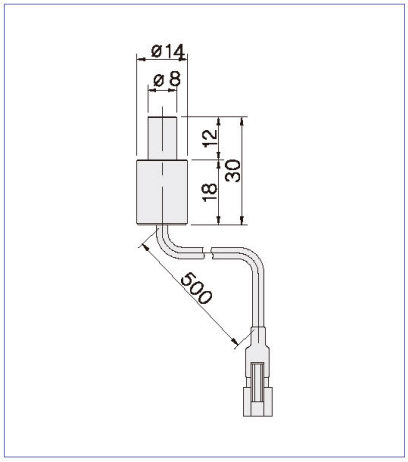
It is ultra high bright spot illumination also enough for coaxial illumination of most of SPO telecentric lens.

This LED guide high contrast compared to halogen source and long life time, low consumption. SPO have several illumination colors like R, G, B, White also can provide another colors.

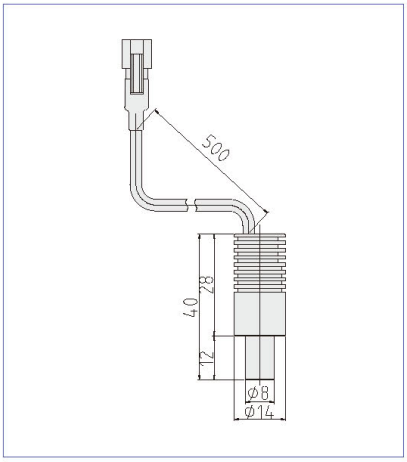
Model	Color	Power Consumption (W)	Forward Voltage (V)	Max. Current (A)	Color Temp & Wavelength
SPO-LED-5㎜ dia.	W,R,G,B	0.1	W,G,B : 3 / R : 2	0.02	White : 5700K~6500K Red : 625㎚ Green : 530㎚ Blue : 470㎚
SPO-LED-0.3W	W,R,G,B	0.3	W,G,B : 3 / R :2	0.1	
SPO-LED-1W	W,R,G,B	1.0	W,G,B : 3.5 / R : 2.5	0.35	
SPO-LED-3W	W,R,G,B	3.0	W,G,B : 3.5 / R : 2.5	0.7	
SPO-LED-5W	W	5.0	W : 3.5	1.2	
SPO-1W SPOT LED	W,R,G,B	1	W,G,B : 3.5 / R : 2.5	0.35	
SPO-LED-8W	W	8	W : 3.5	2	

* Wavelength of visible light on CIE chromatic coorninates.

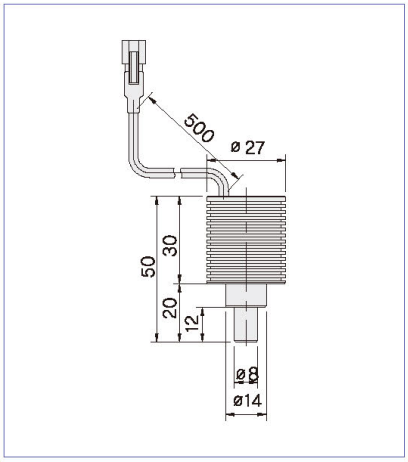
Ø5 LED Illumination



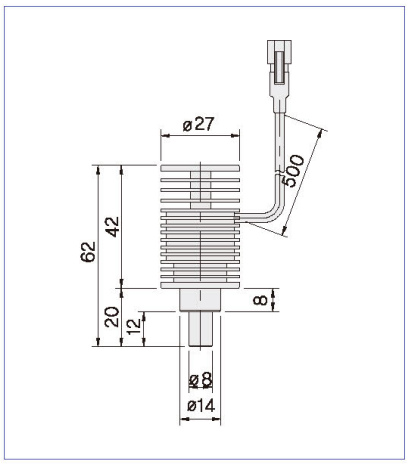
0.3W POWER LED



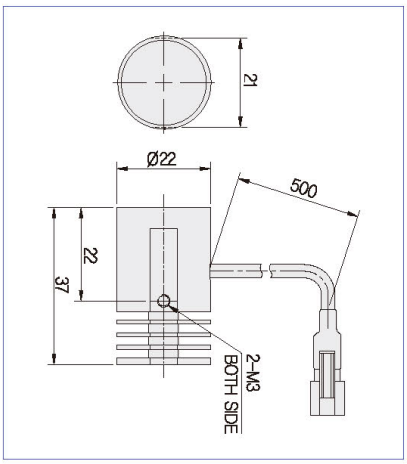
1W POWER LED



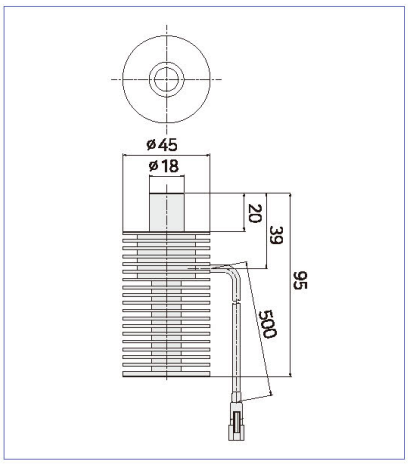
3W/5W POWER LED



1W SPOT LED



8W POWER LED



Ring LED Guide

It is the custom design that available to get perfect illumination condition at each application also ring size, W.D, color of LED ring guide is versatile.
Illumination divergence angle is selected at the condition of application.

Application

- IC marking inspection
- PCB & IC components inspection
- BGA, solder ball position shape and area inspection
- Wafer and edge scratch inspection
- Character recognition

Line LED Guide

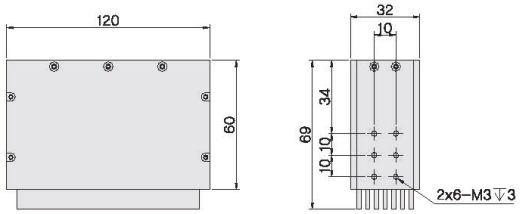
It is the line illumination for line camera's application. There is focusing cylinder lens to concentrate on the beam. It is the very uniform line beam and high power. It is possible to customize any line guide length and colors.

Application

- LCD panel inspection
- Mold & connection inspection
- LCD, PDP glass defect and particles inspection
- Wafer and metal surface inspection.

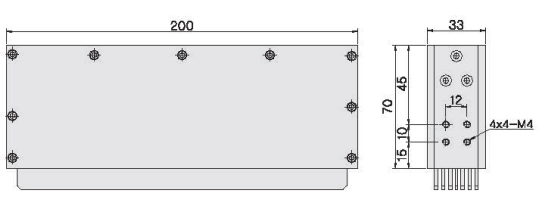
Line Illumination 100㎜

Standard & Precision Optics



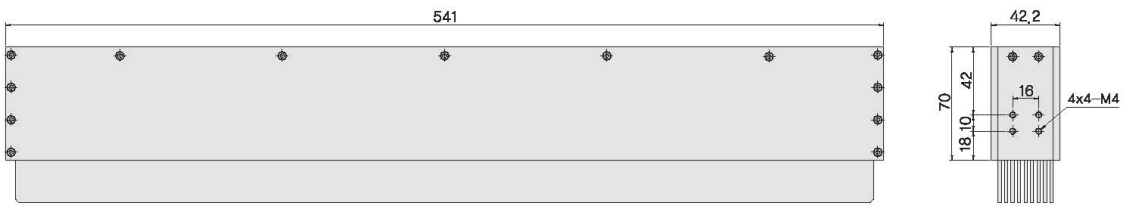
Line Illumination 200㎜

Standard & Precision Optics

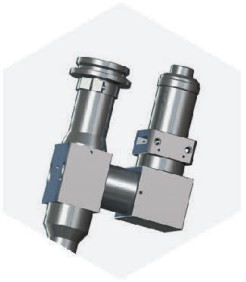


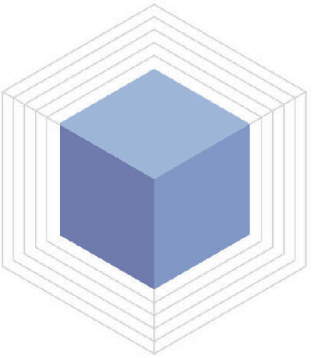
Line Illumination 500㎜

Standard & Precision Optics



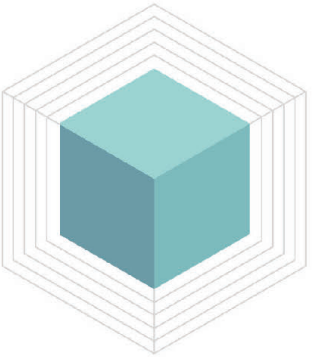
SPO Inc.™
Standard & Precision Optics





OEM

Original Equipment Manufacturer



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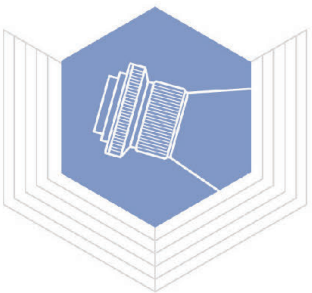
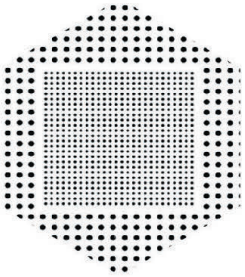
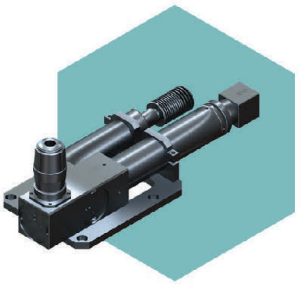




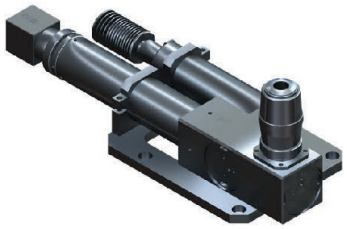
Lens Processing Procedure



Standard & Precision Optics

UV Tube Lens

CMM 0.7X-UV | Wavelength : 266~550㎚



- Critical dimension measurement application with UV objectives.
- UV Koehler illumination with UV illumination lens.

Model	E.F.L of Tube Lens	Magnification of Tube Lens	Illumination Method	Sensor size
CMM 0.7X-UV	140㎜	0.7X	UV Koehler Illumination	1/2"

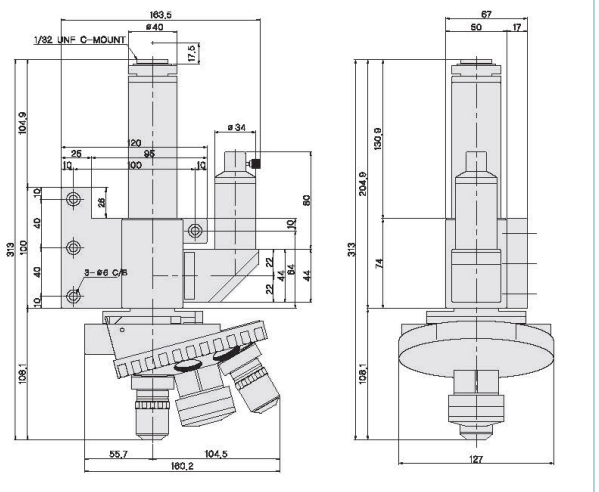
CMM 0.8X-UV | Wavelength : 350~600㎚

- High resolution application compared to visible wavelength(With NUV objective lens).
- Visible Koehler illumination(Good for UV back light illumination).

Model	E.F.L of Tube Lens	Magnification of Tube Lens	Illumination Method	Sensor size
CMM 0.8X-UV	160㎜	0.8X	Visible Koehler Illumination	1/2"

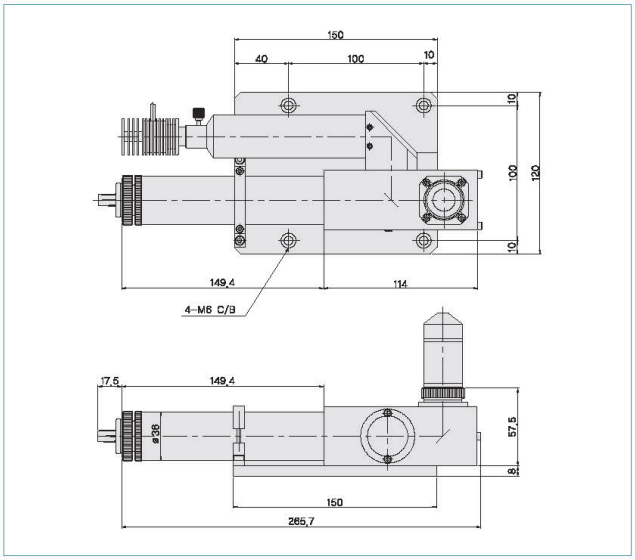
CMM 0.7X-UV

Standard & Precision Optics



CMM 0.8X-UV

Standard & Precision Optics

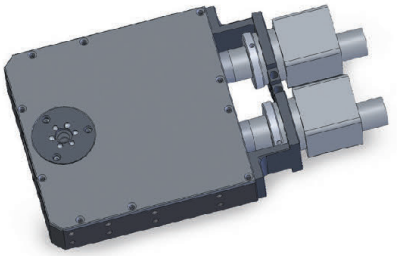


Standard & Precision Optics

Dual Viewing Optical Module

Two cameras & two telecentric lenses module

- Space-saved design.
- Coaxial & ring illumination applied for sample condition.
- Special optical system for bonding machine(FPC, ACF bonding···).
- Magnification and W.D. cab be changed by customer request.



One camera & one telecentric lens module

- Two images(align mark) are overlapped in one image.
- White coaxial illumination for simultaneous acquisition of image.
- Ring illumination(Red & Blue color) for sample condition.
- High resolution & several magnifications.
- Real space-saving design.

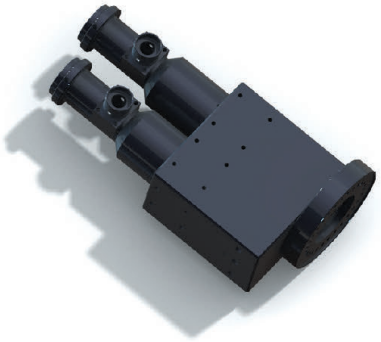
Standard & Precision Optics

Dual Magnification Optical Module

This special designed module has two telecentric lenses and takes the image of one specimen of the same position.

This module can adapt the different magnification's lenses so you can get the image of high and low magnification simultaneously.

The illumination method is coaxial and ring guide types.



Dual Magnification Tube Module

One Magnification type

This lens has the one magnification and the two same images can be captured by two cameras.
The Koehler illumination is used to get the uniformity of intensity.

Magnification of Tube lens : 1.0X

Dual Magnification type

You can get the different magnification's images with one infinite objective.

The magnification of each tube lenses can be changed according to the application.
This also uses the Koehler illumination.

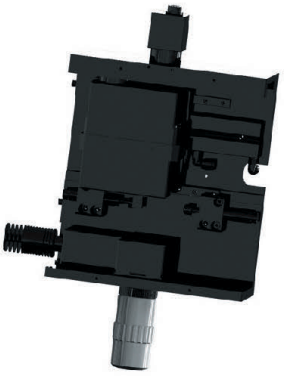
Cylinder shifting type

When you want to take the images of different magnification automatically,
this is really recommended due to the easy sliding method.

You can get the two magnification's images with one infinity objective and one camera.

This module adopts the Air cylinder which changes the each tube lens with very high position accuracy.

The used tube lens is parfocal type so there is no problem to get the sliding.



Standard & Precision Optics

Optical Module for Spectrometry

It can inspect the sample by image which can be acquired with tube lens.
The other port is for spectrometer fiber to measure the spectrum to get thickness information.

- To measure thin layer thickness.
- High resolution optical lens used for monitoring & measuring spectrum.
- Changeable objective lens.
- Support up to 1/2″ CCD camera.
- Wavelength : 400~1100㎚

Standard & Precision Optics

Motorizing Zoom Lens

- This zoom lens is designed especially for large CCD cameras like 4K Line CCD.
- This also has the high resolution and low distortion for over full range of magnification.
- Magnification image : 3.0~5.0X
- W.D : 34㎜
- IRIS diaphragm adapted 26㎜ diagonal.

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Optical Distortion (%)	Sensor size
ZNTL 3050-4K	3.0X	34	3.1	0.11	13.6	121	0.035	4K(7u)
	5.0X	34	2.5	0.133	18.8	60	0.02	4K(7u)

NIR Optics Series

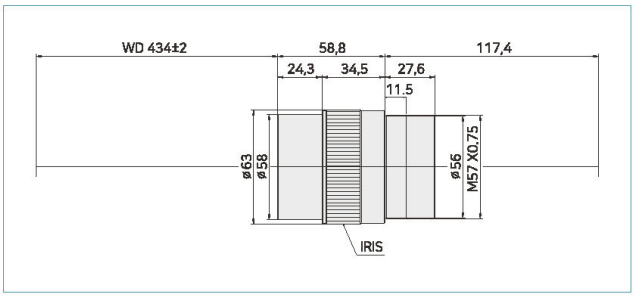
This series have designed for a wavelength band of 770㎚ to 1200㎚ that is used for with Near-Infrared(NIR).
It is good for the wafer pick-up and chip bonding inspection which is in-wafer defects and rear pattern with IR camera.

Model	Mag.	W.D (㎜)	Resolution (㎛)	N.A	F/#	D.O.F (㎛)	Telecentricity (≃degree)	Optical Distortion (%)	Sensor size	Mount
NTL 0.3X-434I-12K-NIR	0.3X	434	25.4	0.024	6.25	1.4㎜		0.03	12K(5u)	M57
TCL 4.0X-80/D-NIR-11	4.0X	80	4.4	0.14	14.3	53.6	0.03	0.085	2/3"(11㎜)	C
TCL 4.0X-80/D-NIR-17	4.0X	80	2.1	0.142	14	31	0.05	0.04	1.1"(16㎜)	C
TCL 4.8X-80/D-NIR-11	4.8X	80	4.4	0.14	17.1	45	0.03	0.05	2/3"(11㎜)	C
TCL 6.0X-81D-NIR-11	6.0X	81	4.1	0.15	20	33	0.03	0.085	2/3"(11㎜)	C
TCL 6.0X-80/D-NIR-17	6.0X	80	2.4	0.14	21	47.5	0.03	0.085	1"(17㎜)	C

* Resolution Wavelength : 1000㎚

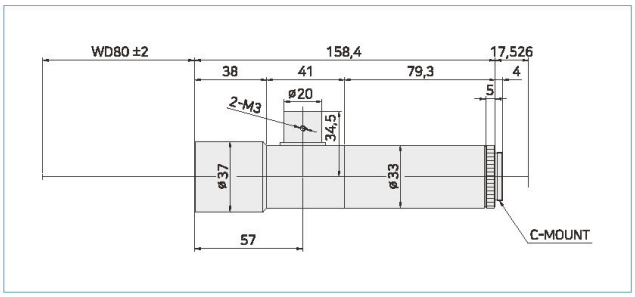
NTL 0.3X-434I-12K-NIR

Standard & Precision Optics



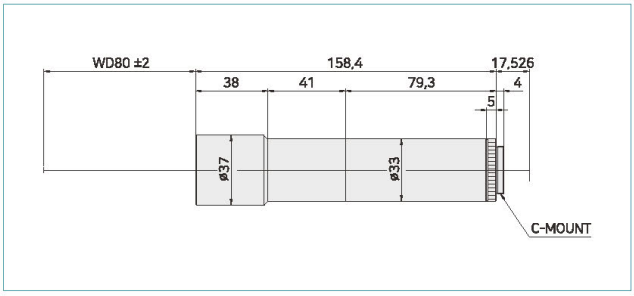
TCL 4.0X-80D-NIR-11

Standard & Precision Optics



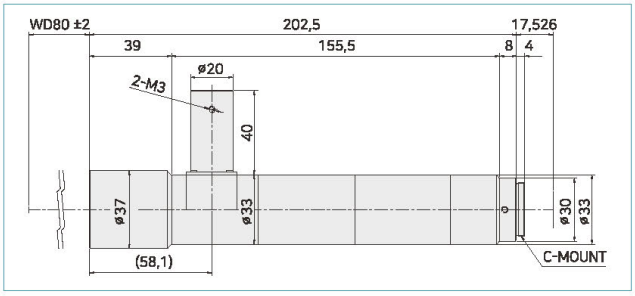
TCL 4.0X-80-NIR-11

Standard & Precision Optics

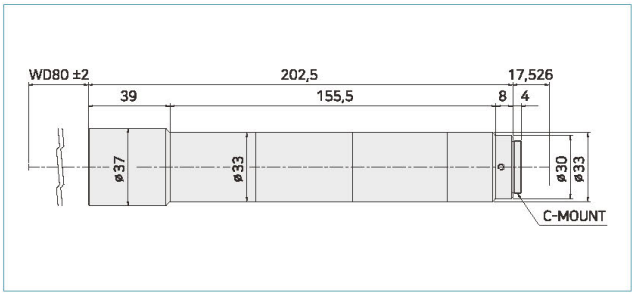


TCL 4.0X-80D-NIR-17

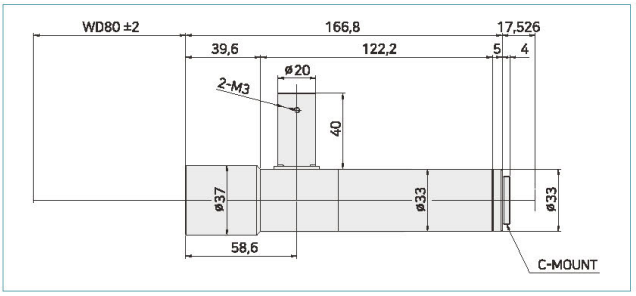
Standard & Precision Optics



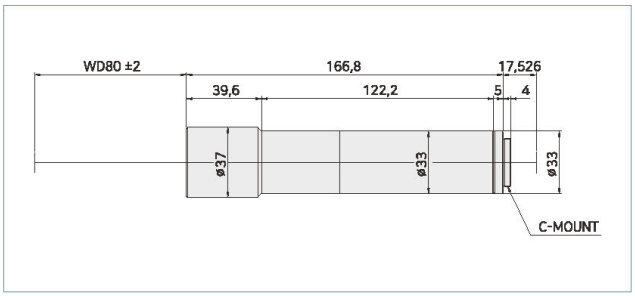
TCL 4.0X-80-NIR-17



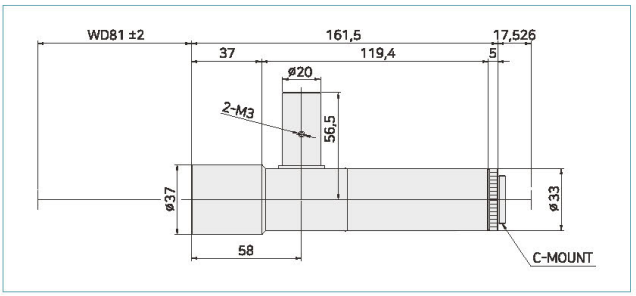
TCL 4.8X-80D-NIR-11



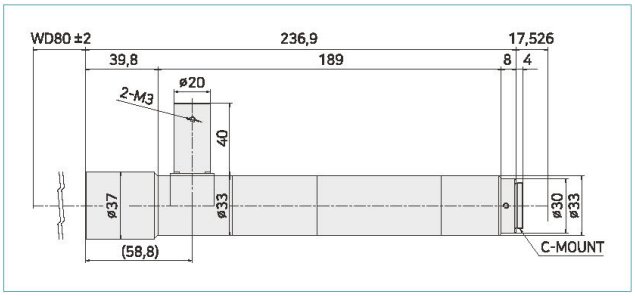
TCL 4.8X-80-NIR-11



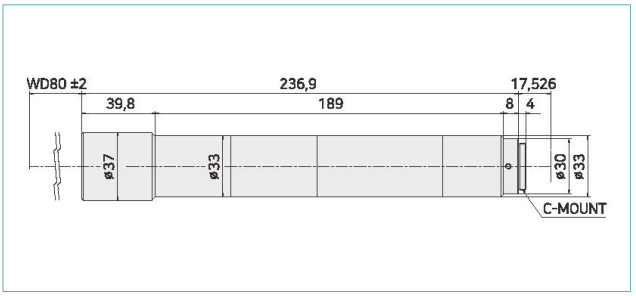
TCL 6.0X-81D-NIR-11



TCL 6.0X-80D-NIR-17

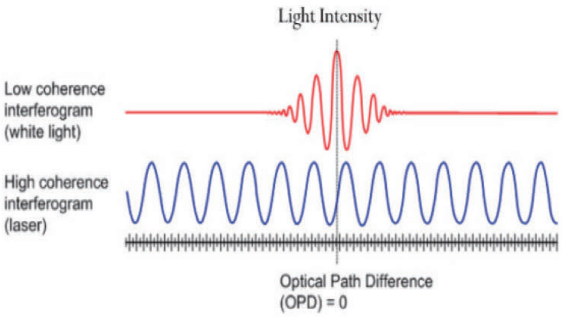


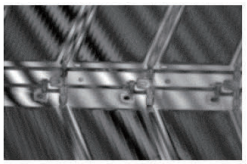
TCL 6.0X-80-NIR-17

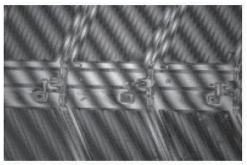


White Light Scanning Interferometer Optical Module

Interferometer is a useful optical tool that divides a beam of light exiting a single source(like laser or LED) into two beams and then recombines them to create an interference pattern.
This pattern can be analyzed to determine the difference in paths for the two beams. This method can get the real data which is non-contact measurement of height for object's surface.
There are 2 types of interferometers generally those are using a laser and white light as the light source.
First, the main reason for using a laser that is the long coherence length of laser light makes it easy to get interference data but it can be irritated the bad result which gives the fake data and incorrect measurements.
On the contrary, WSI(White Light Scanning Interferometer) is the so short coherence length that is an extremely powerful tool to get correct data for precise optical measurements like surface height, depth, size in the 3D applications.

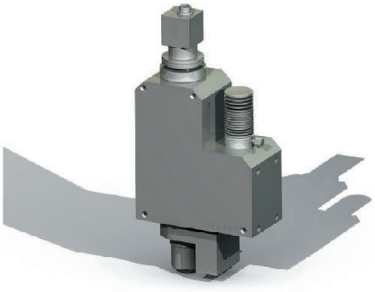


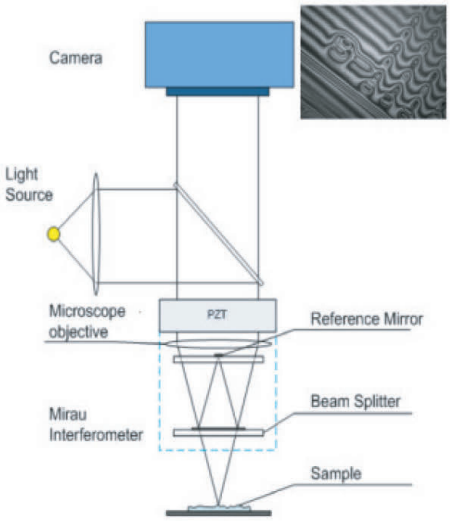

Low Coherence


High Coherence

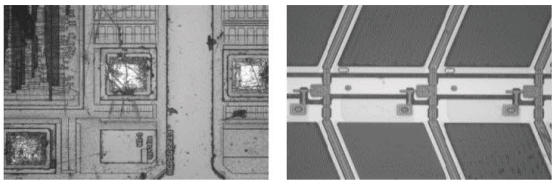
SPO has specialized design of optical module like tube lens, illumination lens, and LED illumination for WSI system. We can also do customized design which is requested by customer who wants to make the WSI system. There is Michelson objective lenses by SPO to achieve special magnification and application.

- Non contact & High accuracy optical module
- LED, BLU, PDP, LCD, OLED's roughness measurement
- Bump and wafer surface measurement





Magnificaiton of Tube Lens	Illumination Method	Hi Powr LED Illumination & Controller
0.4X~2.0X(Fixed Magnificaiton)	Keohler Illumination for even intensity over the entire image	5W Power LED & 2ch Anlog Controller



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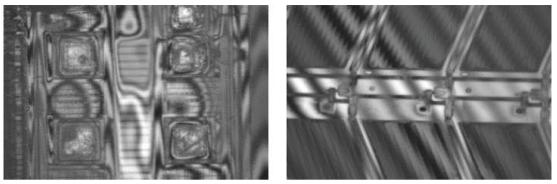
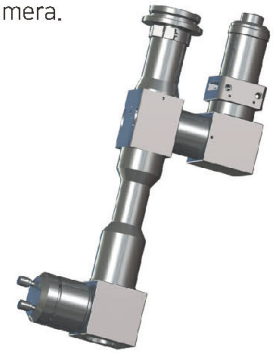


<Interference Image>

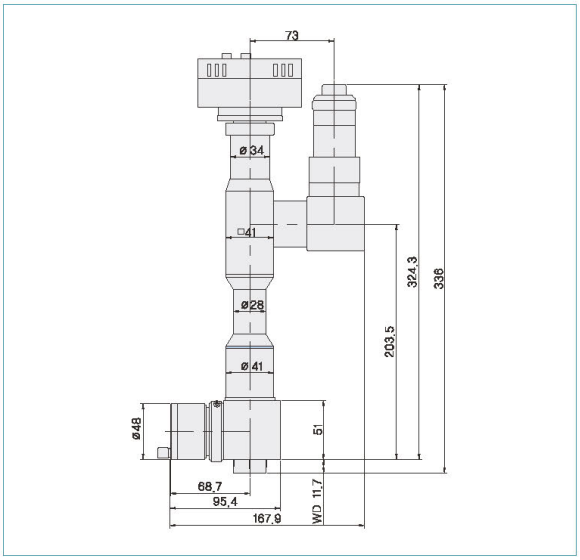
Low Magnification Michelson Interferometer

- Wide F.O.V Michelson optical system.
- F.O.V : 20.5 × 15.1㎜ @ 4M sensor camera.
- Support 4M pixel sensor camera.
- Magnification : 0.8X
- NA : 0.04
- W.D : 11.7㎜
- F/# : 10
- Resolution : 8.4㎛



LOW MAGNIFICATION

Standard & Precision Optics

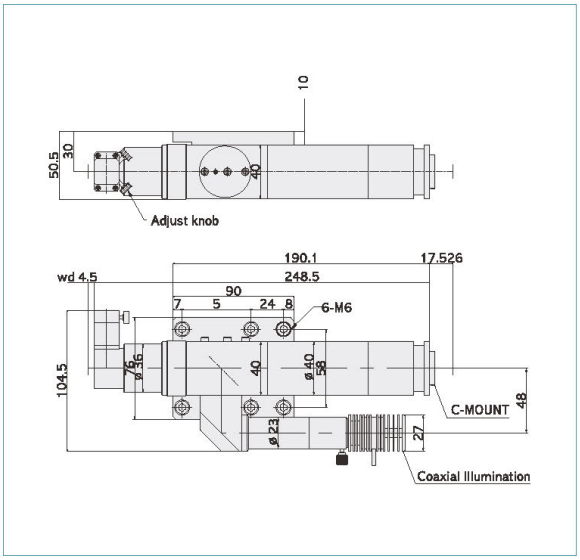


High Magnification Telecentric Michelson Interferometer

- High Magnification Telecentric Michelson optical system.
- F.O.V : 1.37 × 1.37㎜ @ 4M sensor camera.
- Support 4M pixel sensor camera.
- Magnification : 10X
- NA : 0.22
- W.D : 4.5㎜
- F/# : 22
- Resolution : 1.5㎛

HIGH MAGNIFICATION

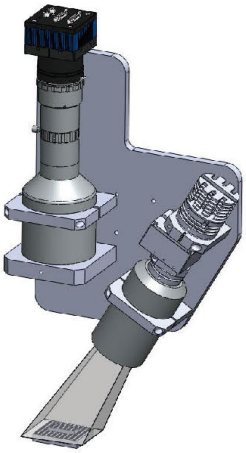
Standard & Precision Optics

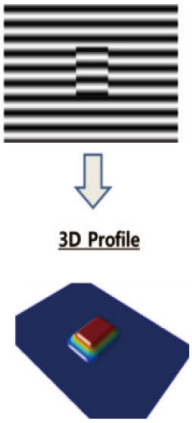


Optical Module for Moire Interferometer

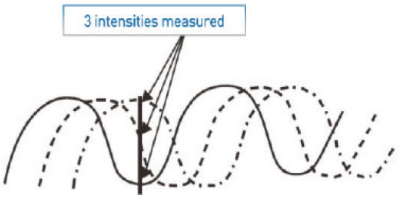
Moire interferometry is a 3D optical technique capable of measuring in-plane displacements(phase shift) with high sensitivity. It is accomplished by projection lens for a grating on an object to two beams and measures the height by means of getting the phase information. It is good for various measurements like BGA Ball, Wafer Bump, PCB components(SPI, AOI) applications. This module is optical system to do the moire interferometer measurement which is used to inspect of components in Lab.

Measuring Lens	Projection Lens	Illumination
- Telecentric lens to avoid any possilbe error. - Magnification is up to objective size. - Sometimes, Non-telecentric lens.	- Very low F/# to get hgh brightness. - Magnification depends on measurement height. - Projection area 25~60㎜.	- Filter with halogen or Ultra power LED source.

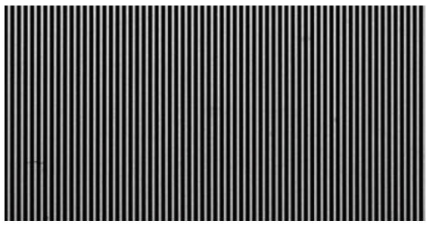




Basic Structure



Intensity Profile



Reference projected image

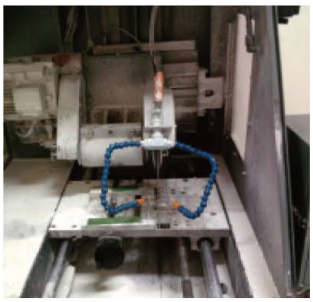
Projected image on objective

Standard & Precision Optics

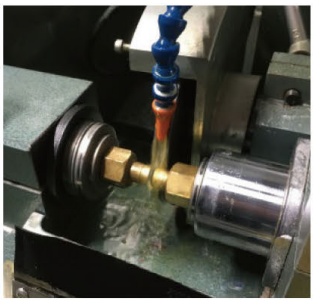
Lens Processing Procedure

SPO have all process those are lens designing to processing and manufacturing by the one-stop procedure. SPO can get the better competitiveness and know-how than other brand also give the high quality lens to the customer in the world.

Standard & Precision Optics
Substrate Cutting



Standard & Precision Optics
Substrate Centering



Standard & Precision Optics
Curve Generator

Standard & Precision Optics
1st Polishing

Standard & Precision Optics
2nd Polishing

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Auto Centering

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