Optical Low-pass Filter

● Terms and Definitions

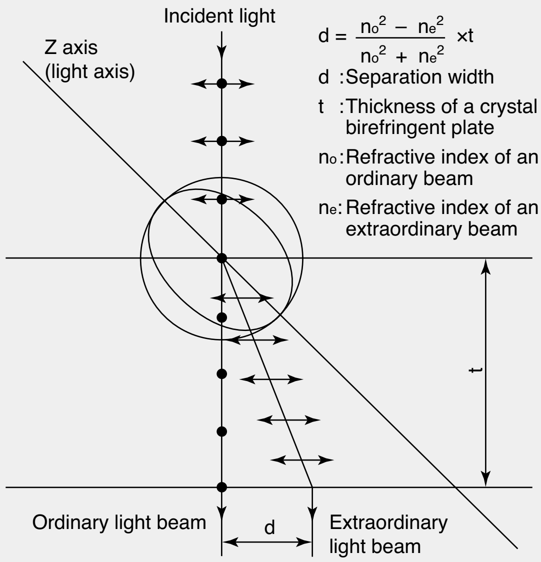
Optical Low-pass Filter: This uses elements that separate ordinary and extraordinary beams of incident light to remove pseudo-signals.

Separation Width: The distance between the ordinary and extraordinary beams separated when light passes through an optical low-pass filter, and this is proportional to the width of the low-pass filter.

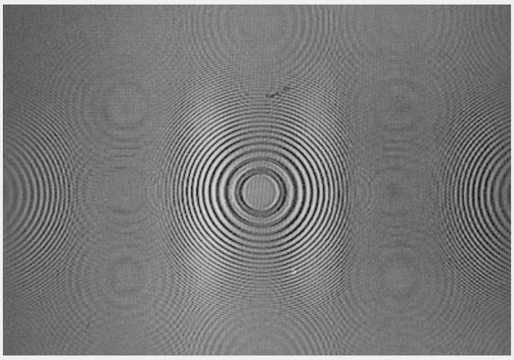
Pseudo-signal: Generated by solid-state image pickup devices, pseudo-signals causes horizontal lines to look jagged or the black-and-white lattice fringe to be colored.

Spectral Characteristic: This indicates transmittance with respect to light wavelength. A coating or glass is used for an optical low-pass filter in order to block out near-infrared light beams.

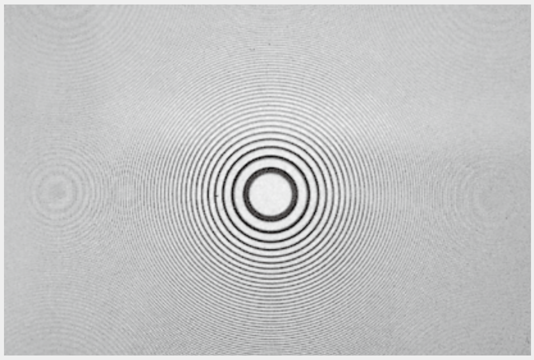
● Relationship between separation width and thickness



Example of how pseudo-signals are removed



CZP chart photographed with no optical low-pass filter used

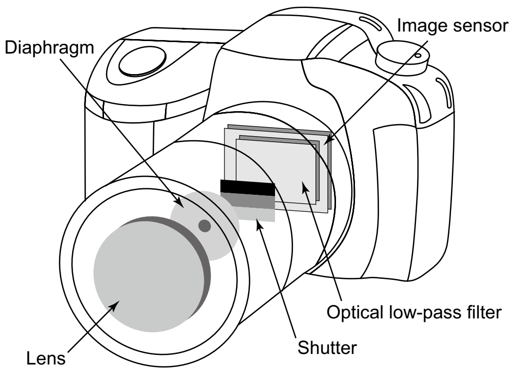


CZP chart photographed with an optical low-pass filter used

(* CZP: Acronym of Circular Zone Plate)

● Application

As shown in the figure below, this filter is used mainly as a spatial frequency low-pass filter for removing pseudo-signals from a camera.



Optical Components

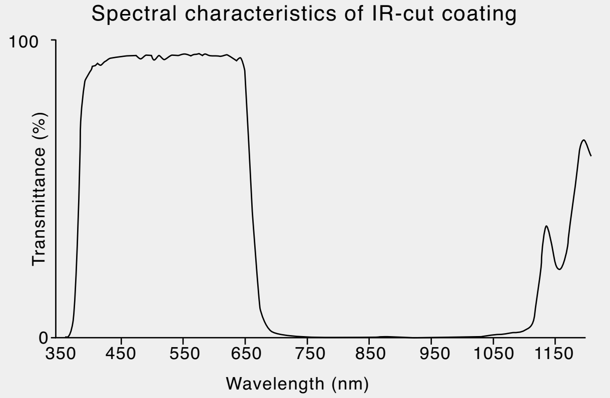
Crystal Bridge to the Future

■ Optical Low-pass Filter

● Features

Single Plate-type Optical Low-pass Filter

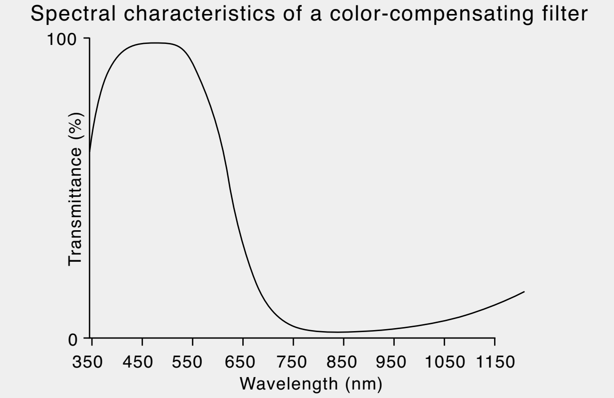
1. A computer controlled grown synthetic quartz crystal ensures this filter has excellent characteristics as a birefringent plate.
2. IR-cut, AR coating, ITO Film and water-repellency coating are available upon request.



Spectral characteristics of IR-cut coating

Bonding-type Optical Low-pass Filter

1. Pseudo-signals can be removed by combining a crystal phase plate (crystal wavelength plate), and an optical low-pass filter in the horizontal, vertical, or any direction of your choice.
2. Filter glass combination and coating are available upon request.



Spectral characteristics of a color-compensating filter

● Standard specifications

Single Plate-type Optical Low-pass Filter

Specifications	Standards
Separation width accuracy (thickness accuracy)	Specified separation width ±0.5 μm (Specified thickness ±0.05 mm)
Outline size	Round plate of φ5 to 30 mm Square plate of 5 x 5 to 40.5 x 48 mm
Light axis accuracy	44°50'±60'
Flatness	Max. 10 Newton rings (λ = 589 nm)

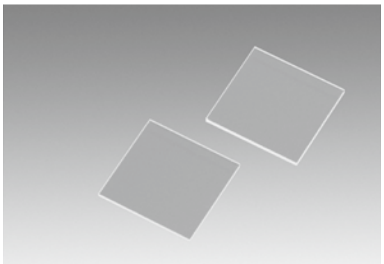
Standard outline size (mm)

(1/2-inch size)
9×10 11×12

(1/3-inch size)
8.5×9

(1/4-inch size)
7.3×7.8

(1/5-inch size)
5.0×5.5



Low-pass filters of other outline sizes can be manufactured upon request.

Bonding-type Optical Low-pass Filter

Specifications	Standards
Outline size	Round plate of φ5 to 30 mm Square plate of 5 x 5 to 40.5 x 48 mm
Light axis accuracy	44°50'±60'
Optical axis bonding accuracy	Specified angle ±60'
Flatness	Max. 20 Newton rings (λ = 589 nm)

Standard outline size (mm)

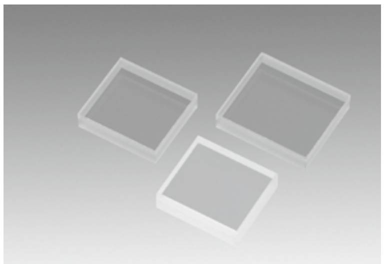
(1/2-inch size)
9×10 11×12

(1/3-inch size)
8.5×9

(1/4-inch size)
7.3×7.8

(1/5-inch size)
5.0×5.5

(For single-lens reflex DSC)
22×28 25.3×29.5 28×40



Bonding-type low-pass filters of other outline sizes can be manufactured upon request.

● Environment Resistance

The following reliability tests guarantee the specified optical characteristics of NDK's optical components.

Subjected to high temperature	For 96 hours at +85 °C
Subjected to low temperature	For 96 hours at –40 °C
Subjected to high temperature and high humidity	For 96 hours at +60 °C and 95 %
Heat shock	10 cycles (one cycle is conducted for 30 minutes at –40 °C and 30 minutes at +85 °C)
Mechanical strength	No flaws after the surface is rubbed with absorbent cotton

■ Optical Low-pass Filter

● How to Determine Optical Low-pass Filter Specifications

When placing an order or asking for information, please inform us of the following items. (Check the boxes.)

1. Size of CCD used

☐ 1/2 inch : ☐ 1/3 inch : ☐ 1/4 inch : ☐ 1/5 inch

2. Number of pixels: ______________________

3. CCD model name: ______________________

4. Infrared absorption filter name: ______________

5. Coating

☐ Present : ☐ Absent

(When coating is present)

•AR single layer ☐ One surface : ☐ Both surfaces

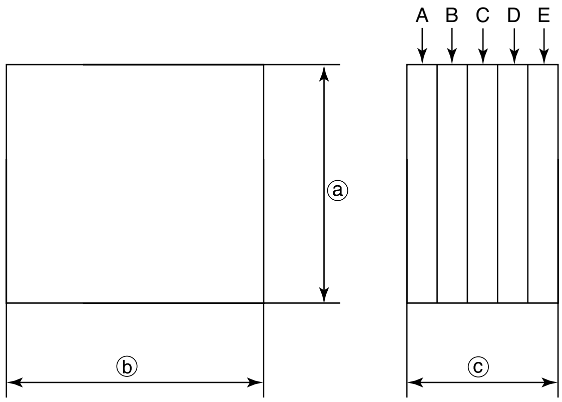
•AR multi-layer ☐ One surface : ☐ Both surfaces

•IR-Cut

•Others

6. Dimensions (part composition)

ⓐ × ⓑ × ⓒ : ______________



	Part Name	Thickness	Tolerance	Angle between the Light Axis and the Principal Surface	In-surface Rotation Angle	Coating	
						A : AR single layer B : AR multi-layer C : IR-Cut coating D : None E : Others	
A						Both surfaces/One surface	A • B • C • D • E
B						Both surfaces/One surface	A • B • C • D • E
C						Both surfaces/One surface	A • B • C • D • E
D						Both surfaces/One surface	A • B • C • D • E
E						Both surfaces/One surface	A • B • C • D • E

* Concerning optical low-pass filters other than square ones, please inform us of your individual specifications.

Crystal Bridge to the Future

■ λ/4 and λ/2 Wavelength Plates

● Terms and Definitions

Crystal Wavelength Plate: An element that uses the velocity difference between ordinary and extraordinary light beams to create a phase difference between both beams; the difference is obtained by using the birefringence of a crystal. When this characteristic is used, a λ/4 wavelength plate converts linearly-polarized light into circularly-polarized light, and a λ/2 wavelength plate converts circularly-polarized light into linearly-polarized light with its polarization plane rotated by 90 degrees.

Wavefront aberration: This indicates the Peak-to-Valley difference of a measured wavefront as a unit of design wavelength: the Zygo Corporation's phase interference system is used to provide the data.

P – V = (maximum phase angle – minimum phase angle)

Extinction Ratio: This indicates a value for the phase accuracy of a wavelength plate, and the conversion equation of the extinction ratio V [%] and phase difference Γ [deg] is as follows:

$$V\,[\%] = 100\times\cos\Gamma$$

$$V = \frac{I_{o,0} - I_{o,90}}{I_{o,0} + I_{o,90}}$$

$$\Gamma = \frac{360}{\lambda}(n_e - n_o) \times t$$

$I_{o,0}$: Output in a parallel Nicol state

$I_{o,90}$: Output in an orthogonal Nicol state

n_e : Refractive index of an extraordinary beam

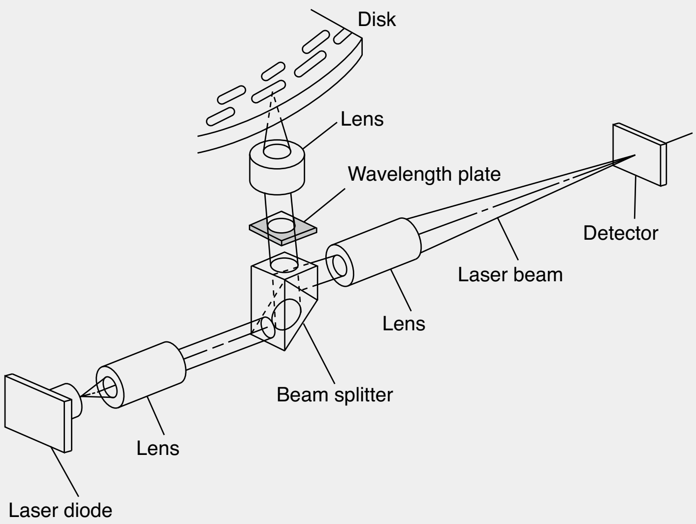
n_o : Refractive index of an ordinary beam

t : Thickness of a phase plate

λ : Design wavelength

● Application

As shown in the figure below, wavelength plates are used mainly for picking up optical information files (DVD, etc) to prevent the back-talk noise of laser beams.



Example of how a wavelength plate is used