NEW
HF-12M series 12 Megapixel, 2/3”

Main features

Advanced optical performance suitable for the top-of-the-range series
- When the iris diaphragm is set at the orange T4 mark on the lens barrel, the HF-12M series delivers the resolving power greater than 2.5 μm pixel pitch on a 2/3-inch sensor (equivalent to 12 megapixels). *1
- The HF-12M series is capable of maintaining sharp high definition with a 2.5 μm pixel pitch within the whole frame area. Each pixel with high optical performance enables stable shooting of product dimensions and appearance.
- The HF-12M series bring out maximum performance of the image sensor with 2.45 μm pixel pitch (BK7232).

FUJINON lenses’ unique “4D High Resolution” performance.
General machine vision lenses share the issue of resolution degradation when the working distance or aperture is changed. The HF-12M features FUJINON lenses’ unique “4D High Resolution” performance. It maintains a high level of constant image sharpness at the center as well as around the edges, while mitigating resolution degradation that typically occurs when changing a working distance or aperture value. This enables the consistent delivery of high-resolution images under a wide variety of install, and shooting conditions.

Ease of installation and high reliability
- Despite being high-resolution lenses with 2.5 μm pixel pitch, all the five models come in a compact form factor with the external dimension of just 45.5mm. This allows installation flexibility even in manufacturing facilities with space constraints.
- General machine vision lenses use iris and focus locking screws with a head protruding out from the lens body, potentially causing interference with the machine vision system. The HF-12M series come with regular locking screws as well as headless compact screws, which can be countersunk into the lens body to minimize interference with the machine vision system, thereby increasing feasibility in system installation and design.
- The lenses are built with a metal mount for durability and robustness.

Technology Supporting the “HF-12M Series”

High-precision glass mold spherical lens technology — Achieving both miniaturization and low distortion —
- In lens design, reducing the number of lenses and forming an image by simply bending light that enters the lens achieves miniaturization. Distortion cannot be controlled if the lenses are only composed of the commonly used aspheric lenses. However, the spherical lens can yield the same results by using multiple spherical lenses, enabling the control of distortion withlarreer. lenses.
- Spherical lenses require precise processing. Fuji can design and manufacture spherical lens within its own group. The precision processing required in the design stage and mass production is realized by accurate die machining technology.
- The HF-12M series realizes both miniaturization and low distortion by implementing the high-precision glass mold spherical lenses.

HF818-12M
- Focal Length: 8mm
- Angle of View: 54.1° x 40.5°
- Working Distance: 90mm
- Operation of focus: Manual
- Operation of iris: Manual
- Minimum F-number: 3.2
- Mount: C mount
- Magnification: 45
- Sensor size (mm): 2/3”
- TV distortion (%): ±0.5%
- Dimension: 45x45x6.5

HF1218-12M
- Focal Length: 12mm
- Angle of View: 39.0° x 29.0°
- Working Distance: 90mm
- Operation of focus: Manual
- Operation of iris: Manual
- Minimum F-number: 2.8
- Mount: C mount
- Magnification: 45
- Sensor size (mm): 2/3”
- TV distortion (%): ±0.5%
- Dimension: 45x45x6.5

HF1618-12M
- Focal Length: 16mm
- Angle of View: 32.5° x 24.0°
- Working Distance: 100mm
- Operation of focus: Manual
- Operation of iris: Manual
- Minimum F-number: 2.8
- Mount: C mount
- Magnification: 45
- Sensor size (mm): 2/3”
- TV distortion (%): ±0.5%
- Dimension: 45x45x6.5

HF2518-12M
- Focal Length: 25mm
- Angle of View: 24.7° x 18.7°
- Working Distance: 90mm
- Operation of focus: Manual
- Operation of iris: Manual
- Minimum F-number: 2.8
- Mount: C mount
- Magnification: 45
- Sensor size (mm): 2/3”
- TV distortion (%): ±0.5%
- Dimension: 45x45x6.5

HF3520-12M
- Focal Length: 35mm
- Angle of View: 21.2° x 15.6°
- Working Distance: 90mm
- Operation of focus: Manual
- Operation of iris: Manual
- Minimum F-number: 2.8
- Mount: C mount
- Magnification: 45
- Sensor size (mm): 2/3”
- TV distortion (%): ±0.5%
- Dimension: 45x45x6.5

*1: At the working distance of 50mm. *2: In the case of HF812M-12M and HF1218M-12M.
Maintaining High-Resolution is about Controlling Aberration. 3 Technologies Supporting “4D high-Resolution”

1 Floating design technology
- Control the drop in resolution caused by changing shooting distances.
  - The lenses are designed to show the best resolution at the shooting distance most commonly used (designated distance). At this distance, the aberrations (spherical aberration, field curvature, distortion) are ideally corrected.
  - Although conventional lens design technology optimally controls aberration at the designated distance, aberration occurred at other distances and lowered resolution. The wide-angle lens in particular had issues with its tendency for curvature of field (peripheral blur).
  - The HF-12M series has implemented “floating design technology.” “Floating lens elements” behind the lens group to focus and enable the HF-12M series to retain its highest resolution regardless of the shooting distance.

2 Eccentricity adjustment technology
- Retaining consistent resolution to the periphery of the image.
  - Misalignment of the axes of the lenses during the manufacturing process prevents the intended performance from being exhibited. It is crucially important to adjust the axis of the lenses to the micrometer level during its manufacturing process.
  - The HF-12M series realized high-resolution consistent all the way to the periphery of the image. No adjustments are necessary because it features proprietary inspection equipment of Fujifilm manufacturing technology and aligning the whole lens construction with micrometer-level adjustments.
  - Fujifilm has proprietary manufacturing technologies to align and control the precision technology needed for manufacturing broadcast lenses that require high-dimensional and consistent qualities, to the manufacture of minute lenses such as camera modules for mobile phones.

3 Glass matching technology (Fujifilm original optical design software “FOCUS”)
- Controls the drop in resolution caused by changing aperture values.
  - Lateral chromatic aberration (color fringe) is the main cause for the drop in resolution when changing the aperture value. Due to the different reflective index of the wavelength, imaging position sometimes differs by color. This leads to the color fringe at the edge of the frame. To control this aberration combination of the glass material matters. HF-12M general glass materials can correct only the 2 colors of RG (Red, Green). Extra-low Dispersion glass materials enables the correction of all these colors at high level.
  - By implementing glass with Extra-low Dispersion characteristics to control lateral chromatic aberration, the HF-12M series have succeeded in maintaining the high-resolution even when changing the aperture values.
  - Fujifilm has developed its original lens design software “FOCUS (Fujifilm Optical Lens Library and Unified System)”, which enables to decide the best glass materials from the infinite combination of possibilities.
### HF-HA series 1.5 Megapixel, 2/3”

<table>
<thead>
<tr>
<th>Model</th>
<th>Focal Length [mm]</th>
<th>F-Stop</th>
<th>Angle of View</th>
<th>Working Distance [mm]</th>
<th>Operating Range</th>
<th>F-Number</th>
<th>Mount</th>
<th>Weight (grams)</th>
<th>Dimensions [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF6HA-1B</td>
<td>6</td>
<td>1.4/16</td>
<td>83°(350°)</td>
<td>1100</td>
<td>Manual</td>
<td>1.4/16</td>
<td>C-Mount</td>
<td>55</td>
<td>45 x 34.8</td>
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<td>HF9HA-1B</td>
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<td>1.4/16</td>
<td>83°(350°)</td>
<td>1000</td>
<td>Manual</td>
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<td>C-Mount</td>
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<td>1.4/16</td>
<td>83°(350°)</td>
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<td>C-Mount</td>
<td>55</td>
<td>45 x 34.8</td>
</tr>
<tr>
<td>HF25HA-1B</td>
<td>25</td>
<td>1.4/16</td>
<td>83°(350°)</td>
<td>500</td>
<td>Manual</td>
<td>1.4/16</td>
<td>C-Mount</td>
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<td>45 x 34.8</td>
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<tr>
<td>HF35HA-1B</td>
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<td>1.4/16</td>
<td>83°(350°)</td>
<td>500</td>
<td>Manual</td>
<td>1.4/16</td>
<td>C-Mount</td>
<td>55</td>
<td>45 x 34.8</td>
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## HF-XA series

<table>
<thead>
<tr>
<th>Product</th>
<th>HF33XA-1</th>
<th>HF33XA-1</th>
<th>HF33XA-1</th>
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<tr>
<td>Mounting distance (mm)</td>
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<td></td>
<td></td>
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<tr>
<td>3</td>
<td>12.7</td>
<td>4.92</td>
<td>3.58</td>
<td>2.96</td>
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<td>5</td>
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## HF-HA series

<table>
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<tr>
<th>Product</th>
<th>HF60HA-18</th>
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<th>HF60HA-18</th>
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<td>Mounting distance (mm)</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>12.7</td>
<td>4.92</td>
<td>3.58</td>
<td>2.96</td>
</tr>
</tbody>
</table>
Technical Information

Image Sizes

- There are several types of imaging sensors for digital cameras, with different image sizes. The aspect ratio of a digital camera sensor is 4:3 (16:9).

<table>
<thead>
<tr>
<th>Image size</th>
<th>Image sensor size</th>
<th>Horizontal</th>
<th>Vertical</th>
<th>Diagonal</th>
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<tbody>
<tr>
<td>C</td>
<td>1&quot;</td>
<td>12.8</td>
<td>9.5</td>
<td>16.5</td>
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<tr>
<td>M</td>
<td>0.85&quot;</td>
<td>8.8</td>
<td>6.5</td>
<td>11.5</td>
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<tr>
<td>D</td>
<td>0.7&quot;</td>
<td>6.6</td>
<td>6.6</td>
<td>9.0</td>
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<tr>
<td>Crop sensor</td>
<td>0.62&quot;</td>
<td>4.4</td>
<td>4.4</td>
<td>6.4</td>
</tr>
</tbody>
</table>

Angle of View

- The angle of view is the object size that can be captured at a specified image size, which is represented by angular measure. Normally, the angle of view is measured assuming a lens is focused at infinity. When using a lens of the same focal length with a different image size, the angle of view will differ.

Depth of Field

- When focusing on a certain area in front of and behind the deep object appears in focus. This area is called the depth of field. The area because the focus appears sharp if the focus misalignment is under a certain value. This certain value is called the permissible circle of confusion.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Image sensor</th>
<th>Permissible circle of confusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.00 mm</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>0.005 mm</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>0.005 mm</td>
<td></td>
</tr>
<tr>
<td>Crop</td>
<td>0.006 mm</td>
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</tr>
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</table>

Focal Length

- The focal length is the distance from the back principal point to the image plane. Lower the focal length wider the image.

Brightness of a Lens (F No.)

- The F No. is an indication of the brightness of the lens. The smaller the value, the brighter the image produced by the lens. The F No. is inversely proportional to the effective diameter of the lens and directly proportional to the focal length.

\[ F = \frac{f}{d} \]

Field of View and Focal Length

1. How to calculate the field of view
   - If the distance to the object is finite, you can use the following formula to calculate the field of view.
   \[ Y = \frac{\gamma}{\gamma'} \times \frac{L}{f} \]

2. How to calculate focal length
   - If the distance to the object is finite, you can use the following formula to calculate the focal length.
   \[ f = \frac{Y}{\gamma'} \times \frac{L}{Y} \]

Distortion

- Distortion is an aberration where the geometric figure of the object is not reproduced faithfully on the image plane. It is generally represented by the level shift of an image point from its ideal position by a percentage of image height or width.

MTF (Modulation Transfer Function)

- MTF (Modulation Transfer Function) represents the declining contrast ratio when shooting a chart consisting of black and white lines.