MFX

Microfocus X-ray Sources Catalog

High-Resolution 2D and 3D Imaging for Non-Destructive Testing

HAMAMATSU

PHOTON IS OUR BUSINESS

Enhancing Industrial X-ray Imaging

Hamamatsu Photonics is a global leading manufacturer specializing in photonic technologies, offering a range of X-ray sensors and imaging solutions. Our product lineup includes Microfocus X-ray sources (MFX) (p.3), photodiode arrays, and advanced imaging systems such as flat panel sensors, TDI and line scan cameras (p.15) packaged in robust enclosures and ready for integration into production lines.

These products are designed for a wide range of industrial non-destructive testing applications, including micro computed-tomography, lithium-ion battery inspection, material inspection, semiconductor inspection, and printed circuit board inspection (p.5).

Hamamatsu's commitment to innovation and quality ensures that its X-ray imaging solutions deliver high sensitivity, resolution, and reliability to meet the rigorous needs of the X-ray market. Visit one of our local European offices or ask for our testing facilities to evaluate your needed application (p.16).

The MFX Series

Hamamatsu offers a comprehensive lineup of Microfocus X-ray sources (MFX) tailored to meet diverse application needs. Featuring a small focal spot size, these sources minimize image blurring and deliver sharp, high-definition results.

Designed to operate between 20 and 300 kV, MFX are specifically developed for 2D and 3D non-destructive testing. The MFX series is available in both sealed and open configurations, making it ideal for a wide range of factory production applications:

Sealed Types

Compact and easy to integrate into systems. These sources are well-suited for applications requiring a small footprint and straightforward installation. These models eliminate the need for high-voltage cables and periodic maintenance, enhancing usability.

Open Types

Featuring high tube voltage and high-resolution characteristics, open type sources enable applications that demand the highest imaging precision. The high-voltage power supply is embedded, and they do not need maintenance on the high-voltage cable. They require additional equipment, such as a vacuum pump, and periodic maintenance.

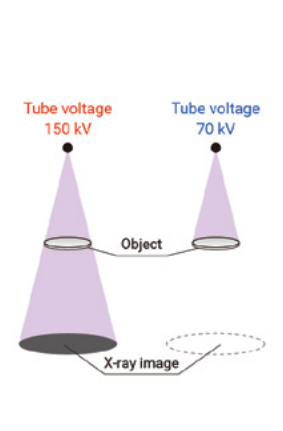
Full product range available p.14
and on our website
www.hamamatsu.com

MFX Characteristics

Tube voltage

X-ray transmission

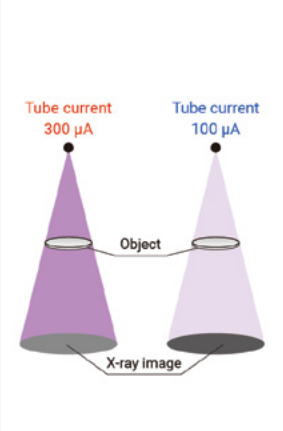
As the X-ray energy increases with the increase in tube voltage, the X-ray transmission to the object also increases. A high-contrast X-ray image can be obtained by setting a tube voltage value suitable for the object.



Tube current / output

X-ray image brightness

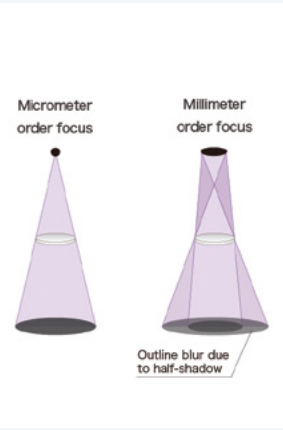
With the tube current value increased, the X-ray dose also increases, and a brighter X-ray image can be obtained. When you inspect an object, the higher the tube current and output are, the shorter the imaging time and the faster the inspection throughput become.



Focal spot size

X-ray image resolution

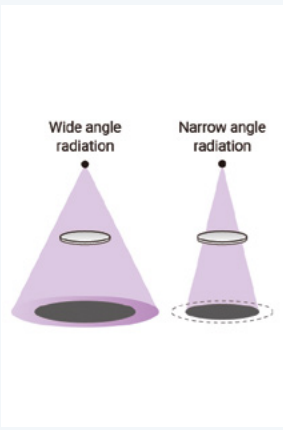
The focal spot size is directly related to the resolution of images. The larger the focal spot size is, the larger the blurry area in images (penumbra) becomes at high magnification imaging. In contrast, the smaller focal spot size enables less blurry X-ray images.



X-ray radiation angle

Imaging area

The wide radiation angle reduces the irradiation distance and enables imaging of large objects. It also enables 3D shape observation by imaging from an oblique direction. Select the optimum X-ray radiation angle according to your application and object.



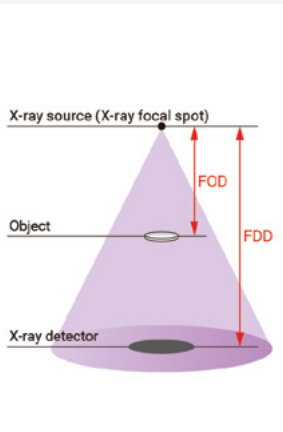
Geometric magnification

X-ray image magnification

When FDD is set to a constant value, the shorter the FOD is, the higher the geometric magnification calculated by FDD/FOD becomes.

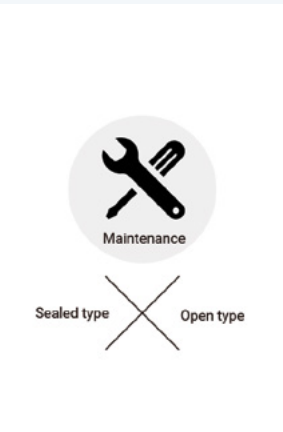
FOD focus to object distance
Distance from X-ray focal spot to object.

FDD focus to detector distance
Distance from X-ray focal spot to X-ray detector.

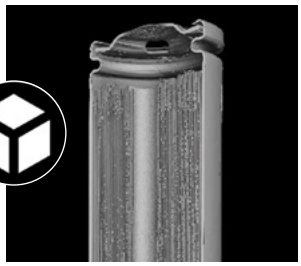


Maintainability

The sealed type is designed so that the X-ray generator is sealed in a vacuum tube. There is no need for periodic maintenance by the customer. The open type requires the customer to replace the cathode/target during periodic maintenance. It can be used continuously for a long period of time and contributes to downtime reduction.



Main Applications

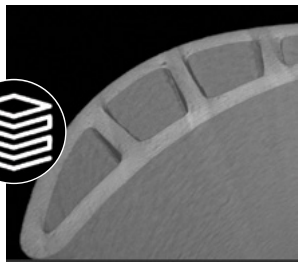


Micro Computed-Tomography

A non-destructive 3D imaging technique that utilizes X-rays to visualize the internal structure of objects with high resolution. Micro-CT is instrumental in analyzing complex internal geometries, detecting defects, and conducting precise measurements across various industries, including materials science and manufacturing.

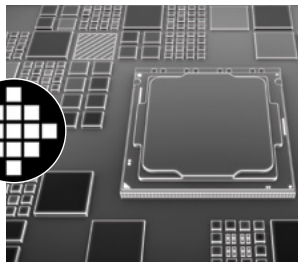
Lithium-ion Battery Inspection (LiB)

An advanced in-line imaging method ensuring LiB quality by detecting minute foreign particles and defects that could lead to heat generation or ignition. X-ray imaging facilitates the examination of internal layers, verifying uniformity and correct positioning, which are crucial for battery performance and safety.



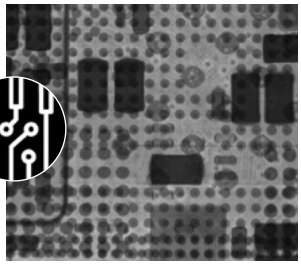
Material Inspection

In general, for material or product inspection, Microfocus X-ray sources are used to inspect parts in industries like aerospace, automotive and telecommunication. They can detect flaws that might affect the performance, durability, or safety of these components. Examples are typically die-cast, cable and rubber/plastic items inspection. Material inspection can include a variety of different applications, among which we can list geological samples inspection.



Semiconductor Inspection

High-precision, non-destructive inspection methods that ensure reliability in semiconductor products. X-ray imaging techniques, such as microfocus X-ray computed tomography, detect internal defects like voids and cracks, contributing to improved product quality and performance.



Printed Circuit Board (PCB) Inspection

High-resolution inspection of components and connections to ensure safety and functionality. Automated X-ray inspection (AXI) systems detect solder joint defects, misalignments, and other anomalies in PCBs, facilitating process optimization and anomaly detection in electronics manufacturing.

Latest MFX

L9421-02

Category: Sealed
Target Type: Reflection
Max. Tube Voltage: 90 kV
Max. Tube Current: 200 µA
Max. Output: 8 W
Min. X-ray Focal Spot Size: 5 µm
X-ray Beam Angle*: 39 degrees
Focus to Object Distance (FOD)*: 9.5 mm
Interface: RS-232C

Applications

Material Inspection

L10101

Category: Sealed
Target Type: Reflection
Max. Tube Voltage: 100 kV
Max. Tube Current: 200 µA
Max. Output: 20 W
Min. X-ray Focal Spot Size: 5 µm
X-ray Beam Angle*: 42 degrees
Focus to Object Distance (FOD)*: 6.8 mm
Interface: RS-232C

Applications

Micro Computed-Tomography

*approx.

L17431

Category: Sealed
Target Type: Reflection
Max. Tube Voltage: 100 kV
Max. Tube Current: 200 µA
Max. Output: 20 W
Min. X-ray Focal Spot Size: 7 µm
X-ray Beam Angle*: 68 degrees
Focus to Object Distance (FOD)*: 6.8 mm
Interface: RS-232C

Applications

Micro Computed-Tomography

L9631

Category: Sealed
Target Type: Reflection
Max. Tube Voltage: 110 kV
Max. Tube Current: 800 µA
Max. Output: 50 W
Min. X-ray Focal Spot Size: 15 µm
X-ray Beam Angle: 62 degrees
Focus to Object Distance (FOD)*: 16.8 mm
Interface: RS-232C

Applications

Material Inspection

Lithium-ion Battery Inspection

Printed Circuit Board Inspection

*approx.

Latest MFX

L12531-01

Category: Sealed
Target Type: Transmission
Max. Tube Voltage: 110 kV
Max. Tube Current: 200 µA
Max. Output: 16 W
Min. X-ray Focal Spot Size: Min. resolution 2 µm
X-ray Beam Angle*: 120 degrees
Focus to Object Distance (FOD)*: 1 mm
Interface: RS-232C

Applications

Micro Computed-Tomography

Printed Circuit Board Inspection

Semiconductor Inspection

L15851

Category: Sealed
Target Type: Transmission
Max. Tube Voltage: 130 kV
Max. Tube Current: 300 µA
Max. Output: 39 W
Min. X-ray Focal Spot Size: 11 µm
X-ray Beam Angle*: 166 degrees
Focus to Object Distance (FOD)*: 0.25 mm
Interface: RS-232C

Applications

Printed Circuit Board Inspection

*approx.

L9181-05

Category: Sealed
Target Type: Reflection
Max. Tube Voltage: 130 kV
Max. Tube Current: 300 µA
Max. Output: 39 W
Min. X-ray Focal Spot Size: 16 µm
X-ray Beam Angle*: 100 degrees
Focus to Object Distance (FOD)*: 13 mm
Interface: RS-232C

Applications

Material Inspection
Lithium-ion Battery Inspection
Printed Circuit Board Inspection

L9181-02

Category: Sealed
Target Type: Reflection
Max. Tube Voltage: 130 kV
Max. Tube Current: 300 µA
Max. Output: 39 W
Min. X-ray Focal Spot Size: 5 µm
X-ray Beam Angle*: 45 degrees
Focus to Object Distance (FOD)*: 13 mm
Interface: RS-232C

Applications

Material Inspection
Printed Circuit Board Inspection

*approx.

L12161-07

Category: Sealed
Target Type: Reflection
Max. Tube Voltage: 150 kV
Max. Tube Current: 500 µA
Max. Output: 75 W
Min. X-ray Focal Spot Size: 5 µm
X-ray Beam Angle*: 43 degrees
Focus to Object Distance (FOD)*: 17 mm
Interface: RS-232C

Applications

Material Inspection
Lithium-ion Battery Inspection
Printed Circuit Board Inspection

L14351-01

Category: Sealed
Target Type: Reflection
Max. Tube Voltage: 180 kV
Max. Tube Current: 500 µA
Max. Output: 90 W
Min. X-ray Focal Spot Size: 20 µm
X-ray Beam Angle*: 90 degrees
Focus to Object Distance (FOD)*: 19.8 mm
Interface: RS-232C

Applications

Material Inspection
Lithium-ion Battery Inspection
Printed Circuit Board Inspection

*approx.

L14351-02

Category: Sealed
Target Type: Reflection
Max. Tube Voltage: 180 kV
Max. Tube Current: 500 µA
Max. Output: 90 W
Min. X-ray Focal Spot Size: 20 µm
X-ray Beam Angle*: 62 degrees
Focus to Object Distance (FOD)*: 19.8 mm
Interface: RS-232C

Applications

Material Inspection
Lithium-ion Battery Inspection
Printed Circuit Board Inspection

L10711-25

Category: Open
Target Type: Transmission
Max. Tube Voltage: 160 kV
Max. Tube Current: 200 µA
Max. Output: 9.6 W
Min. X-ray Focal Spot Size: Min. resolution 0.25 µm
X-ray Beam Angle*: 120 degrees
Focus to Object Distance (FOD)*: 0.3 mm
Interface: RS-232C

Applications

Micro Computed-Tomography
Semiconductor Inspection

*approx.

L10711-26

Category: Open
Target Type: Transmission
Max. Tube Voltage: 160 kV
Max. Tube Current: 200 µA
Max. Output: 9.6 W
Min. X-ray Focal Spot Size: Min. resolution 0.2 µm
X-ray Beam Angle*: 120 degrees
Focus to Object Distance (FOD)*: 0.3 mm
Interface: RS-232C/Ethernet

Applications

Micro Computed-Tomography

Semiconductor Inspection

L10801

Category: Open
Target Type: Reflection
Max. Tube Voltage: 230 kV
Max. Tube Current: 1000 µA
Max. Output: 200 W
Min. X-ray Focal Spot Size: Min. resolution 4 µm
X-ray Beam Angle*: 40 degrees to 60 degrees
Focus to Object Distance (FOD)*: 4.6 mm
Interface: RS-232C

Applications

Material Inspection

Micro Computed-Tomography

*approx.

L12721

Category: Open
Target Type: Reflection
Max. Tube Voltage: 300 kV
Max. Tube Current: 1000 µA
Max. Output: 200 W
Min. X-ray Focal Spot Size: Min. resolution 4 µm
X-ray Beam Angle*: 40 degrees to 60 degrees
Focus to Object Distance (FOD)*: 4.6 mm
Interface: RS-232C

Applications

Material Inspection

Micro Computed-Tomography

*approx.

Latest MFX

Type No.	Max. Tube Voltage	Max. Tube Current	Max. Output	Min. X-ray Focal Spot Size	X-ray Beam Angle (approx.)	Focus to Object Distance (FOD) (approx.)	Applications*
Sealed Type							
L9421-02	90 kV	200 µA	8 W	5 µm	39 degrees	9.5 mm	♦
L10101	100 kV	200 µA	20 W	5 µm	42 degrees	6.8 mm	●
L17431	100 kV	200 µA	20 W	7 µm	68 degrees	6.8 mm	●
L9631	110 kV	800 µA	50 W	15 µm	62 degrees	16.8 mm	■ ♦ –
L12531-01	110 kV	200 µA	16 W	Min. resolution 2 µm	120 degrees	1 mm	● ▲ –
L15851	130 kV	300 µA	39 W	11 µm	166 degrees	0.25 mm	–
L9181-05	130 kV	300 µA	39 W	16 µm	100 degrees	13 mm	■ ♦ –
L9181-02	130 kV	300 µA	39 W	5 µm	45 degrees	13 mm	♦ –
L12161-07	150 kV	500 µA	75 W	5 µm	43 degrees	17 mm	■ ♦ –
L14351-01	180 kV	500 µA	90 W	20 µm	90 degrees	19.8 mm	■ ♦ –
L14351-02	180 kV	500 µA	90 W	20 µm	62 degrees	19.8 mm	■ ♦ –
Open Type							
L10711-25	160 kV	200 µA	9.6 W	Min. resolution 0.25 µm	120 degrees	0.3 mm	● ▲
L10711-26	160 kV	200 µA	9.6 W	Min. resolution 0.2 µm	120 degrees	0.3 mm	● ▲
L10801	230 kV	1000 µA	200 W	Min. resolution 4 µm	40 degrees to 60 degrees	4.6 mm	● ♦
L12721	300 kV	1000 µA	200 W	Min. resolution 4 µm	40 degrees to 60 degrees	4.6 mm	● ♦

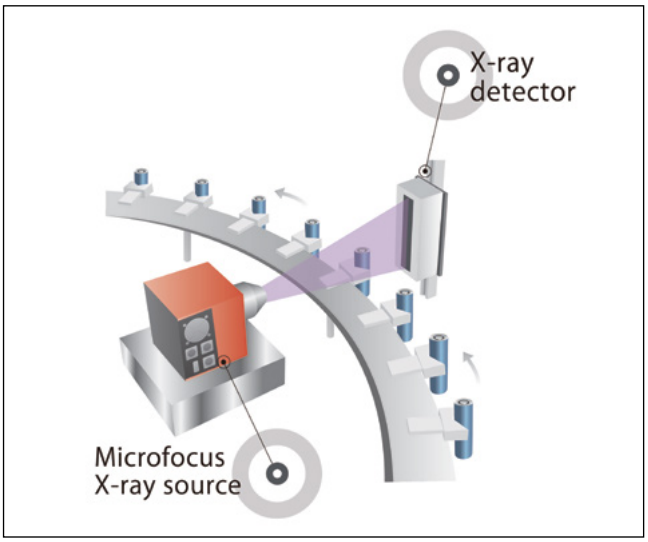
* Applications				
Micro Computed-Tomography	**Lithium-ion Battery Inspection**	**Material Inspection**	**Semiconductor Inspection**	**Printed Circuit Board Inspection**
●	■	♦	▲	–

Our X-ray detection capabilities

X-ray TDI Cameras

These cameras are widely used in in-line inspection because they can continuously acquire high-resolution X-ray images.

C12300 series



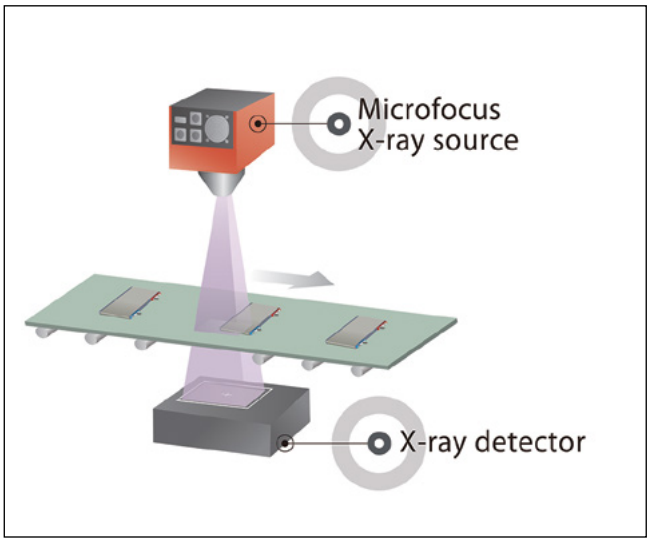
Visit our website to see our full range of line scan cameras

www.hamamatsu.com

X-ray Flat Panel Sensors

These cameras are widely used in 3D inspection because they can be used to acquire single-shot images of an object.

C16401SK-51



Visit our website to see our full range of X-ray flat panel sensors

www.hamamatsu.com

Visit our European Local Offices

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Worldwide organization

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