

MFX

Microfocus X-ray Sources Catalog

Hamamatsu Photonics' Microfocus X-ray Sources
for High-Resolution 2D and 3D Imaging
in 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 (page 6), photodiode arrays, and advanced imaging systems such as flat panel sensors, TDI and line scan cameras (page 7) packaged in robust enclosures and ready for integration into production lines.

These products are designed for diverse industrial non-destructive testing applications, including micro-computed tomography, lithium-ion battery inspection, structural material, semiconductor, and PCB analysis (page 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 (page 8).



The Microfocus X-ray Sources Series

Hamamatsu offers a comprehensive lineup of Microfocus X-ray (MFX) sources 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.6
and on our website

www.hamamatsu.com

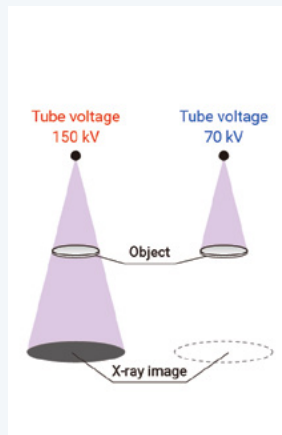


The Microfocus X-ray Sources Characteristics

Tube voltage

X-ray transmission

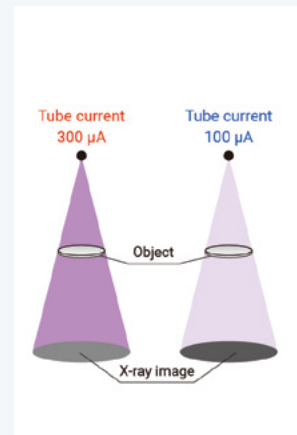
As the X-ray energy increases with the increase in tube voltage, the X-ray transmission to the object also increases. A high-contrast X-ray image can be obtained by setting a tube voltage value suitable for the object.



Tube current / output

X-ray image brightness

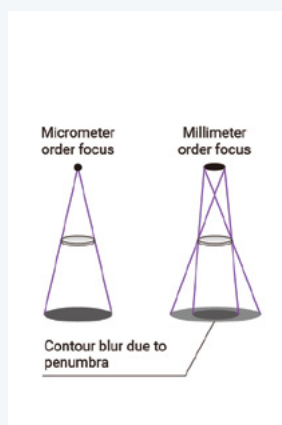
With the tube current value increased, the X-ray dose also increases, and a brighter X-ray image can be obtained. When you inspect an object, the higher the tube current and output are, the shorter the imaging time and the faster the inspection throughput become.



Focal spot size

X-ray image transition

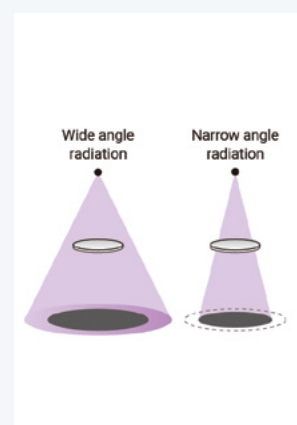
The focal spot size is directly related to the resolution of images. The larger the focal spot size is, the larger the blurry area in images (penumbra) becomes at high magnification imaging. In contrast, the smaller focal spot size enables less blurry X-ray images.



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.



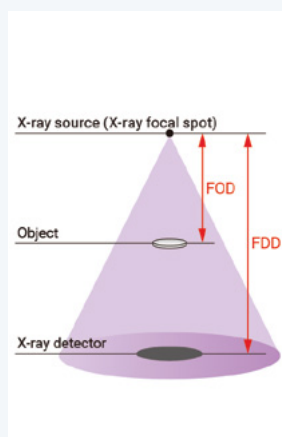
Geometric magnification

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.

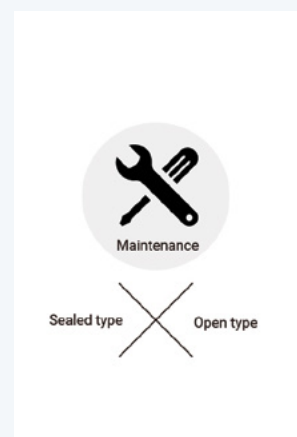
FDD focus to object distance
Distance from X-ray focal spot to object.

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.



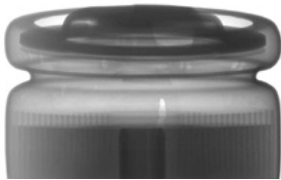
Main Applications



Micro Computed-Tomography



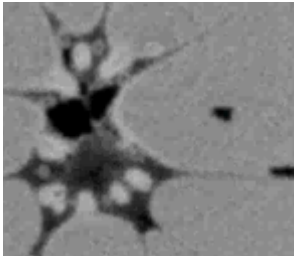
A non-destructive 3D imaging technique that utilizes X-rays to visualize the internal structure of objects with high resolution. Micro-CT is instrumental in analyzing complex internal geometries, detecting defects, and conducting precise measurements across various industries, including materials science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



Lithium-ion Battery Inspection (LiB)



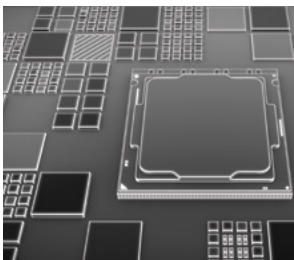
An advanced in-line imaging method ensuring LiB quality by detecting minute foreign particles and defects that could lead to heat generation or ignition. X-ray imaging facilitates the examination of internal layers, verifying uniformity and correct positioning, which are crucial for battery performance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



Material Analysis



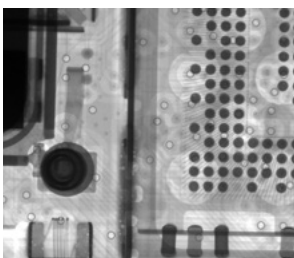
In general, for material or product inspection, Microfocus X-ray sources are used to inspect parts in industries like aerospace, automotive and telecommunication. They can detect flaws that might affect the performance, durability, or safety of these components. Examples are typically die-cast, cable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



Semiconductor Analysis



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 Analysis



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 Microfocus X-ray Sources

Part no.	Tube Voltage	Tube Current	Max. Output	X-ray Focal Spot Size	X-ray Beam Angle	Focus to Object Distance (FOD)	Applications**		
Sealed Type									
L9181-02 ^[1]	40 kV to 130 kV	10 µA to 300 µA	39 W	5 µm at 4 W	45 degrees	13 mm	●		◆
L9181-05 ^[1]	40 kV to 130 kV	10 µA to 300 µA	39 W	16 µm to 50 µm	100 degrees	13 mm	■	◆	—
L9421-02 ^[2]	20 kV to 90 kV	0 µA to 200 µA (8 W Max.)	8 W	7 µm to 80 µm	39 degrees	9.5 mm	●		◆
L10101	40 kV to 100 kV	10 µA to 200 µA	20 W	5 µm to 30 µm (5 µm at 4 W)	42 degrees	6.8 mm	●		
L10321	40 kV to 100 kV	10 µA to 200 µA	20 W	5 µm to 30 µm (5 µm at 4 W)	118 degrees	7.3 mm	●		
L10951	40 kV to 110 kV	10 µA to 800 µA (50 W Max.)	50 W	15 µm to 80 µm	62 degrees	16.8 mm	●		■
L12161-07 ^[3]	40 kV to 150 kV	10 µA to 500 µA (30 W Max.)	75 W	5 µm (at 4 W)	43 degrees	17 mm	■		◆
L12531-01 ^[4]	40 kV to 110 kV	0 µA to 200 µA	16 W	Min. resolution 2 µm	120 degrees	1 mm	●	—	▲
L14351-01	40 kV to 180 kV	0 µA to 500 µA	90 W	20 µm to 200 µm	90 degrees	19.8 mm	■	◆	—
L14351-02	40 kV to 180 kV	0 µA to 500 µA	90 W	20 µm to 200 µm	62 degrees	19.8 mm	●	◆	—
L15851 ^[4]	90 kV to 130 kV	0 µA to 300 µA	39 W	11 µm (at 8 W) to 25 µm (at 39 W)	166 degrees	0.25 mm	—		
Open Type									
L10711-03 ^[3]	20 kV to 160 kV	0 µA to 200 µA	8 W Beryllium window	0.25 µm*	140 degrees	0.5 mm	●	◆	▲
			16 W Diamond window						
L10801 ^[3]	20 kV to 230 kV	0 µA to 1000 µA	200 W	Min. resolution 4 µm	40 degrees	5 mm	●		◆
L12721 ^[3]	20 kV to 300 kV	0 µA to 1000 µA at 20 kV to 230 kV	200 W	Min. resolution 4 µm	40 degrees to 60 degrees	5 mm	●	◆	
		0 µA to 500 µA at 231 kV to 300 kV							

^[1] All part no. are available in continuous operation version, L9181 series is also available in pulsed version.

^[2] L9421-02 suitable for off-line inspection. In-line version model available.

^[3] With external control unit.

^[4] Transmission type.

* Suitable measurement conditions are necessary.

** Applications				
Micro Computed-Tomography	Lithium-ion Battery Inspection	Materials Analysis	Semiconductor Analysis	Printed Board Circuit Analysis
●	■	◆	▲	—

Our X-ray detecting capabilities

X-ray TDI Cameras

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



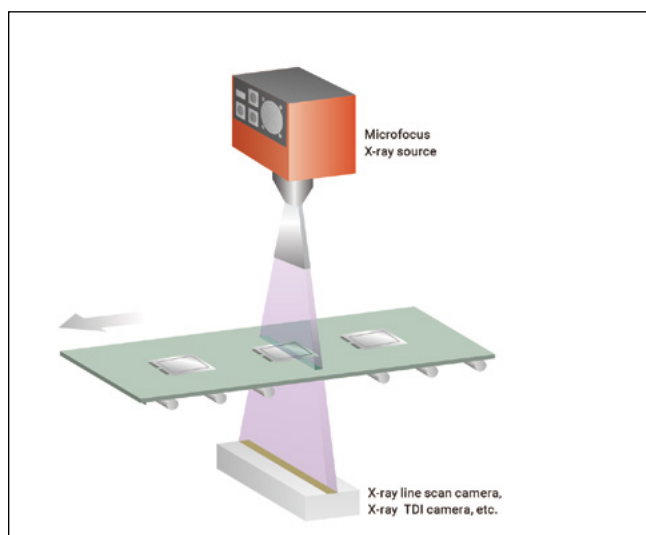
C12300 series

X-ray 2D Flat Panel Sensors

These cameras are widely used in 3D inspection and structural analysis because they irradiate an object with X-rays all at once.

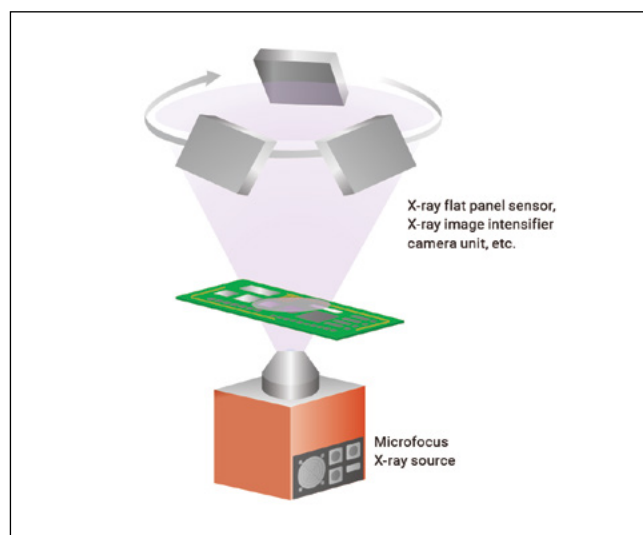


C16401SK-51



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

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