X-ray TDI camera

C12300 series

X-ray image of cylindrical lithium-ion battery (LiB)

The Pioneer of Inline X-ray Inspection

High speed readout

Compatible with high speed up to 144 m/min

Wide area

Maximum detection width: 293 mm

High resolution

Pixel size: 48 µm

High sensitivity

TDI 150 steps integration

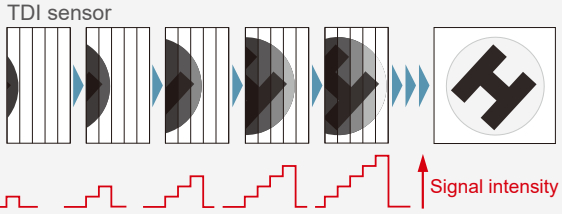
HAMAMATSU

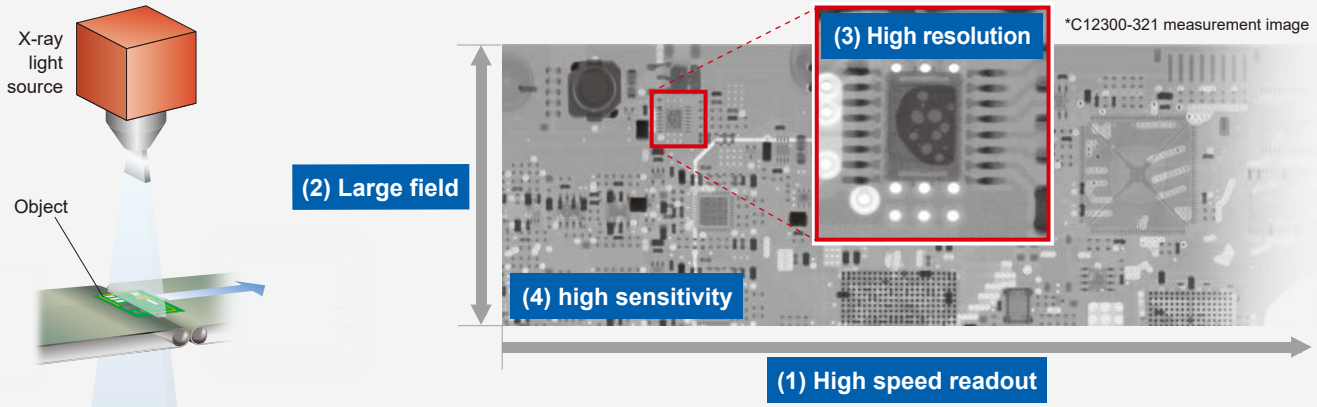
PHOTON IS OUR BUSINESS

Features of an X-ray TDI camera

TDI is a technology for achieving high-speed, high-resolution and high-sensitivity scanning over a wide area.

Time Delay Integration is a technology of scanning in which a frame transfer device produces a continuous video image of a moving object by means of a stack of linear arrays aligned with and synchronized to the motion of the object to be imaged in such a way that,
as the image moves from one line to the next, the integrated charge moves along with it, providing higher resolution at lower light levels is possible with a line-scan camera.



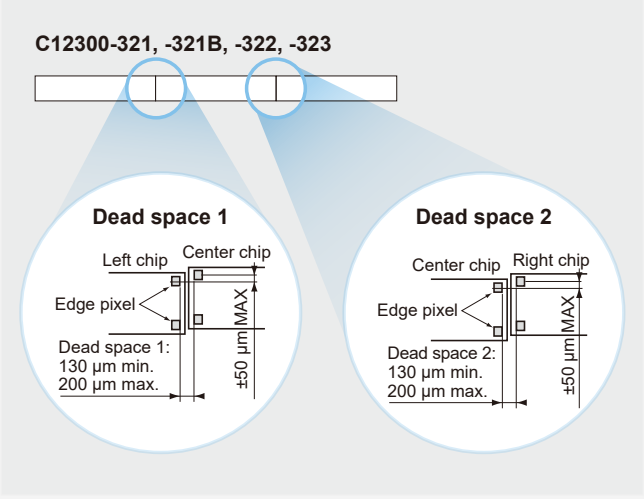


(1) New line-up of ultra-high-speed models with TDI line rate of 50 kHz that support high-speed models compatible with a maximum inspection line speed of 144 m/min.
(2) Maximum detection width: 293 mm. Also, bidirectional scanning contributes to improve the cycle time of large objects.
(3) The pixel size of 48 µm allows minute contaminants in sheet components and also solder defects on electronic substrates to be inspected at high precision.
(4) Sharp, clear images can be acquired even in dark samples by performing 150-line integration using TDI technology.

Selectable two types of sensor arrangement

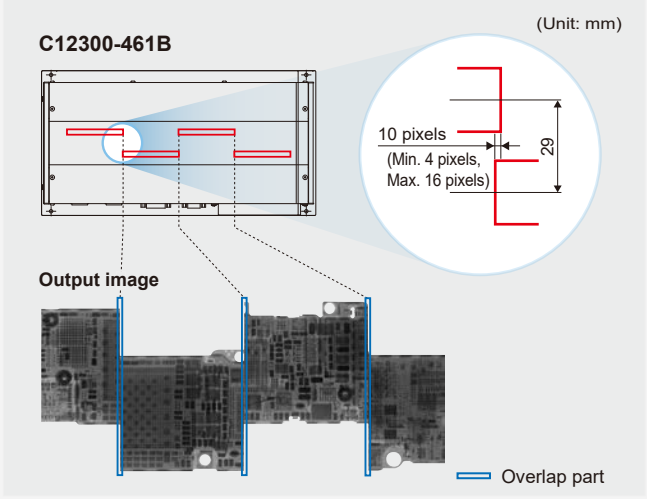
Highly versatile straight type (C12300-121, -321, -321B, -322, -323)

Arranging the sensors in a straight line enables images that are properly aligned with each other to be acquired continuously. High-definition images can be acquired in a variety of inline inspections. In the model below, there are dead spaces.



Overlapped type specialized for inspection of minute contaminants (C12300-461B)

Alternately arranging adjacent sensors to slightly overlap each other eliminates dead spaces. This type of sensor arrangement is specialized for inspection of minute contaminants that may fail to be detected owing to dead spaces. Images are outputted in a staggered manner as shown in the picture below.



Product line-up

C12300-321
C12300-322
Standard model

This standard model has a detection width of 221 mm and compatible tube voltage of 130 kV. The user can choose from two models to suit the application, the C12300-321 that scans at a speed of 20 kHz or the C12300-322 that scans at a high speed of 30 kHz.

C12300-121 NEW
Ultra high-speed model

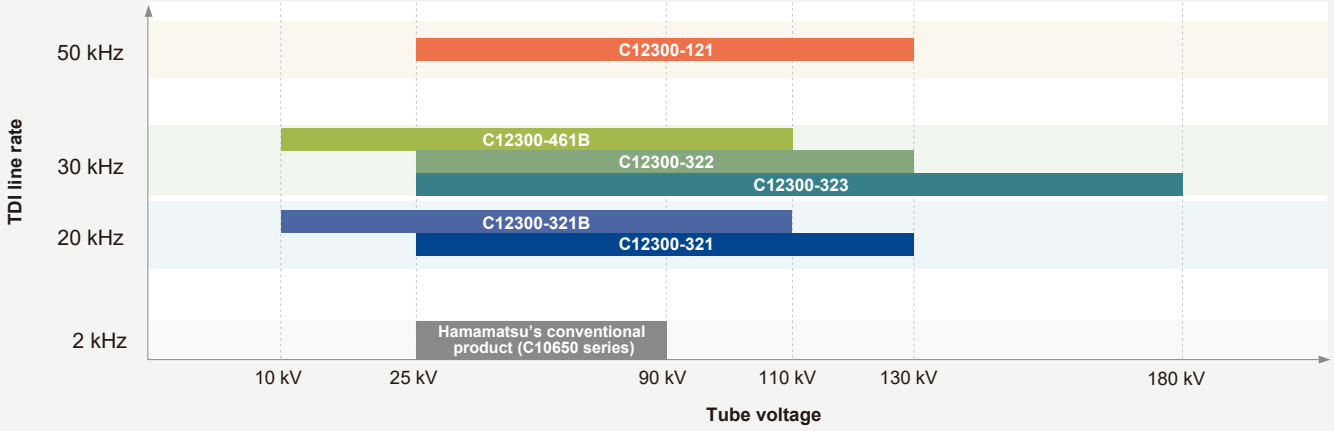
On this model, an ultra-high scan speed of 50 kHz has been achieved by shortening the detection width to 73 mm. This is ideal for capturing images of relatively small objects that are conveyed at high speed.

C12300-323 NEW
High energy-compatible model

This model is compatible with tube voltages up to a maximum of 180 kV. It can be used for capturing images of metal or other hard substances that require high energy to transmit X-rays through.

C12300-321B
C12300-461B
Low energy-compatible model

This model supports X-ray inspection at low energy of 10 kV and upwards. It is ideal in capturing images of low-density or thin objects that are difficult to generate contrast on by irradiation of X-rays.



Specifications

Type number		C12300-121 (NEW)	C12300-321	C12300-321B	C12300-322	C12300-323 (NEW)	C12300-461B
Scintillator		CsI Scintillator					
Effective X-ray tube voltage range*1		Approx. 25 kV to 130 kV		Approx. 10 kV to 110 kV	Approx. 25 kV to 130 kV	Approx. 25 kV to 180 kV	Approx. 10 kV to 110 kV
CCD pixel size		48 µm × 48 µm					
Number of pixels		1536 (H) × 150 (V)	4608 (H) × 150 (V)				6144 (H) × 150 (V)
X-ray sensitive area		73.728 mm (H) × 7.2 mm (V)	221.1 mm (H) × 7.2 mm (V)				293.4 mm (H) × 7.2 mm (V)*2
Line speed		0.864 m/min to 144.0 m/min	0.576 m/min to 57.6 m/min		0.576 m/min to 86.4 m/min		
TDI line rate	1×1	Max. 50.0 kHz (144.0 m/min)	Max. 20.0 kHz (57.6 m/min)		Max. 30.0 kHz (86.4 m/min)		
	Binning 2×2	Max. 40.0 kHz (230.4 m/min)	Max. 15.0 kHz (86.4 m/min)		Max. 25.0 kHz (144.0 m/min)		
Digital interface		Camera Link					
Interface (Camera Link)		Base Configuration					Full Configuration
Digital output		12 bit					16 bit
Power supply		DC +15 V					
Power consumption		Approx. 30 VA	Approx. 45 VA				
Ambient operating temperature		0 °C to +40 °C					
Ambient operating humidity		30 % to 80 % (With no condensation)					
Ambient storage temperature		–10 °C to +50 °C					
Ambient storage humidity		30 % to 80 % (With no condensation)					

*1: Usable range of X-ray strength may vary depending on the tube current, the tube voltage and the distance.
*2: As sensors are the overlapped type, calculation is performed with overlap between sensors taken into consideration.

Application

Lithium-ion Battery (LiB) Inspection

Lithium-ion batteries (LiB) are widely used as the power source of electric vehicles as a substitute for gasoline or as the batteries for smartphones and tablet terminals. Due to the increasing demand for LiBs, X-ray inspection for ensuring the quality of LiBs or for improving product yield is becoming more critical.

The C12300 series enables high-definition inline inspection due to its high resolution of 48 µm/pixel and its capability to acquire distortion-free images without stopping moving objects.

Recommended models

C12300-121 **(ultra high-speed model)**

C12300-321 **(standard model)**

C12300-322 **(standard model)**

C12300-323 **(high energy-compatible model)**

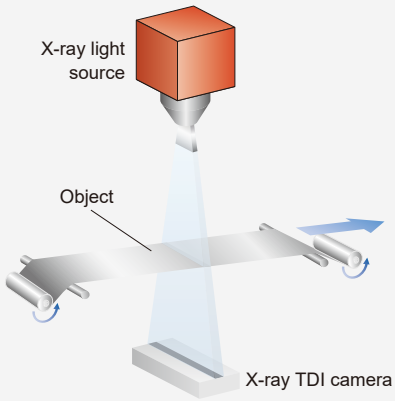
C12300-461B **(low energy-compatible / overlapped model)***

*As this is a overlapped type of sensor, boundary areas sometimes might not be completely matching when the output images are reconstructed as a single image, in particular, when capturing images of objects that have distinct thickness.

C12300-121

Continuous imaging of moving objects

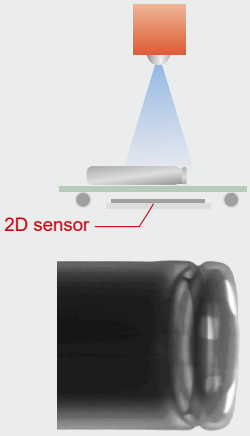
X-ray TDI cameras can continuously inspect moving objects inline as they are brought into scanning range and without stopping objects such as metal sheets and separators that are fed in from roll to roll. Continuous inspection in this way means that these cameras can be applied in high-speed lines.



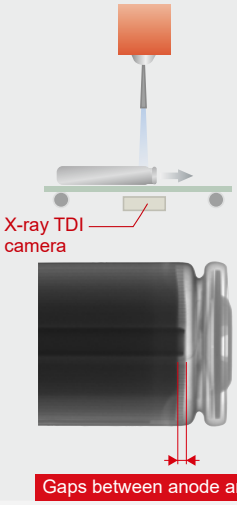
Imaging of object locations without directing X-rays at an angle

With X-ray inspection using 2D sensors, distortion sometimes occurs in images outside of the irradiation center of the X-ray source as a result of incident X-rays being directed at an angle to objects. This necessitates positional adjustment at each individual image capture point to ensure accurate inspection. Whereas, with X-ray TDI cameras, X-rays are irradiated at right angles to the carrying direction, and imaging is performed by integrating continuously captured images. As a result, distortion-free images can be acquired.

Inspection by 2D sensor



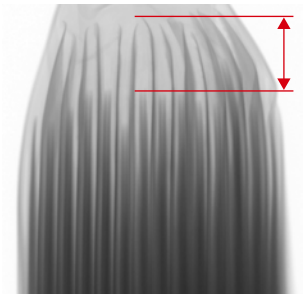
Inspection by X-ray TDI camera



Imaging example

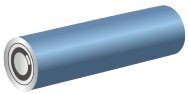
Inspection of distance between electrodes of laminated LiBs

Sample: Laminated LiB
Detector: C12300-322
Tube voltage: 100 kV
Magnification: 10 times

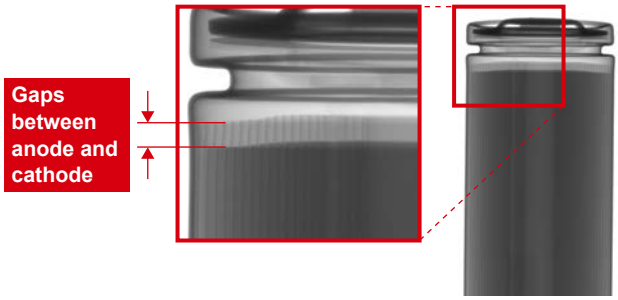


The C12300 series can acquire distortion-free images in the carrying direction, the positions of electrodes in laminated LiBs can be precisely inspected by scanning them in their lamination direction. High-resolution, high-speed inspection can be achieved by combining an X-ray TDI camera with a microfocus X-ray source.

Inspection of distance between electrodes of cylindrical LiBs

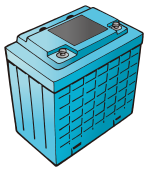


Sample: Cylindrical LiB
Detector: C12300-121
Tube voltage: 100 kV
Magnification: 5 times

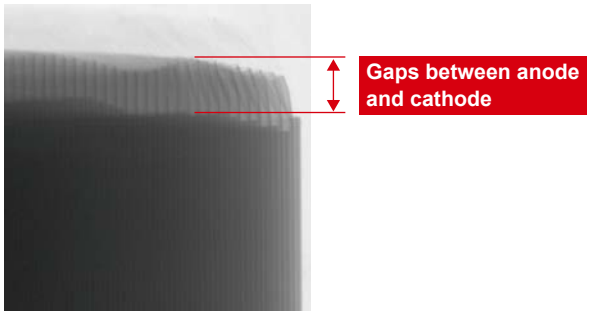


The C12300-121 can acquire images at a maximum scanning speed of 50 kHz. It is ideal for the high-speed inspection of cylindrical LiBs where many objects to be inspected are carried in continuously.

Inspection of distance between electrodes of wound type LiBs that have distinct thickness



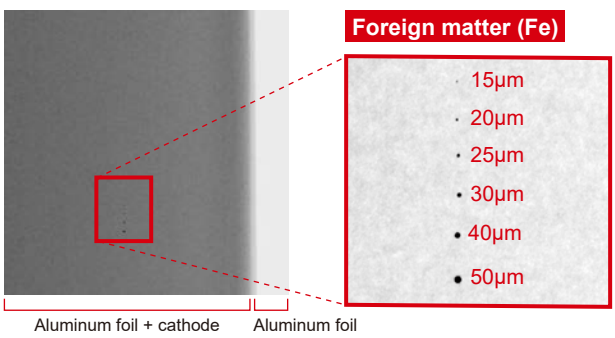
Sample: Winding LiB
(thickness 100 mm)
Detector: C12300-323
Tube voltage: 180 kV
Magnification: 4 times



The C12300-323 is compatible for capturing images using tube voltages up to a maximum of 180 kV. Even on winding LiBs that have thickness and that require high energy to transmit X-rays through, the positions of electrodes and their layers can be precisely inspected.

Inspection of contaminants on cathode sheets

Sample: Cathode sheet
Detector: C12300-461B
Tube voltage: 40 kV
Magnification: 10 times



The C12300-461B has high sensitivity at the low tube voltage region and its sensors are configured in a staggered arrangement. As even minute contaminants on thin objects can be detected, it is ideal for the inspection of sheet materials such as cathodes and anodes, and separators on LiBs.

Printed Circuit Board (PCB) Inspection

Developments in communications technology and automobiles have increased the demand for printed circuit boards (PCB) which are vital in our lives. This has resulted in higher demand for speed and accuracy in the inspection of defects on PCBs.

The C12300 series features high sensitivity and is compatible with fast line speeds. As a result, it helps improve cycle time in inspection of defects such as voids that occur in soldered parts of electronic components on PCBs, uneven coating, and cracks in substrates.

As a result of its bidirectional scanning function and compatibility with tube voltages up to a maximum of 180 kV, it is also compatible with a variety of PCBs.

Recommended models

C12300-321 **(standard model)**

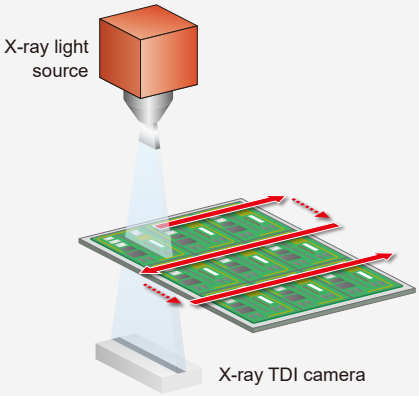
C12300-322 **(standard model)**

C12300-323 **(high energy-compatible model)**

C12300-323

Bidirectional scanning supported

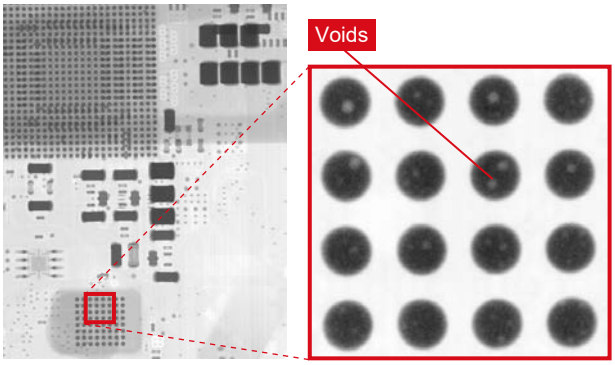
The C12300 series is capable of bidirectional scanning (switching of scan direction to match the carrying direction). As a result, this series supports connection to differently oriented lines that use the same inspection systems and systems where scanning is performed in reverse when a defect is judged. It also helps improve cycle time in the inspection of large objects such as PCBs for servers.



Imaging example

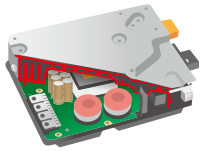
Inspection of voids in solder

Sample: PCB of camera unit for driving assist system
Detector: C12300-322
Tube voltage: 130 kV
Magnification: 5 times

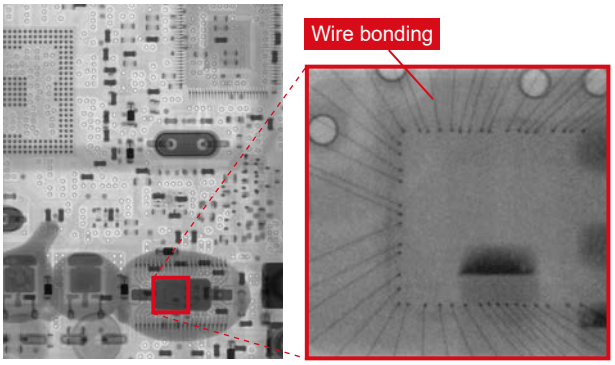


As bidirectional scanning is supported, the C12300 series can efficiently scan the entire surface of PCBs mounted with electronic components, and can inspect voids in solder at high resolution.

Inspection of wire bonding



Sample: ECU PCB
Detector: C12300-323
Tube voltage: 180 kV
Magnification: 5 times



The C12300-323 is compatible with tube voltages up to a maximum of 180 kV. It is capable of transmitting X-rays through heat sinks and other metal parts to inspect for defects in wire bonding on PCBs.

Food Inspection

More and more processed foods, such as frozen food and baby food, that make our lives more convenient are appearing on the market. Consequently, concern for safety and security of food has increased all the more, which has resulted in the demand for higher precision in the inspection of packages and detection of contaminants.

This low energy-compatible model of the C12300 series can also inspect soft objects that are difficult to generate contrast on, such as in the inspection of residual fish bones and in the inspection of food package bite-in, at high sensitivity.

Recommended models

C12300-321B (low energy-compatible model)

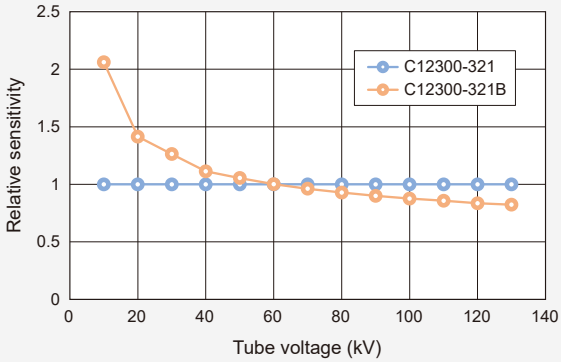
C12300-461B (low energy-compatible / overlapped model)*

* As this is a overlapped type of sensor, boundary areas sometimes might not be completely matching when the output images are reconstructed as a single image, in particular, when capturing images of objects that have distinct thickness.

C12300-321B

High sensitivity at low energy

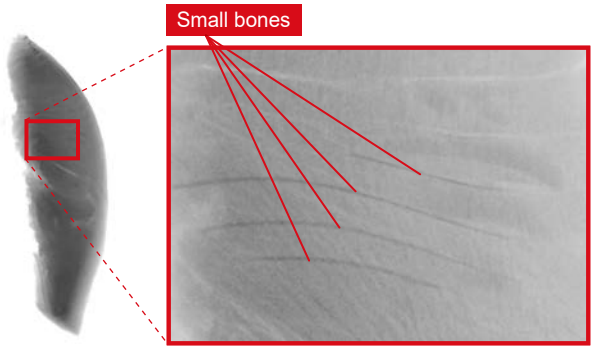
The X-ray incident sections and scintillators of the camera on the C12300-321B and C12300-461B have been specially designed to ensure low energy compatibility. This allows images to be acquired at high sensitivity at a tube voltage region lower than other models.



Imaging example

Inspection of residual fish bones

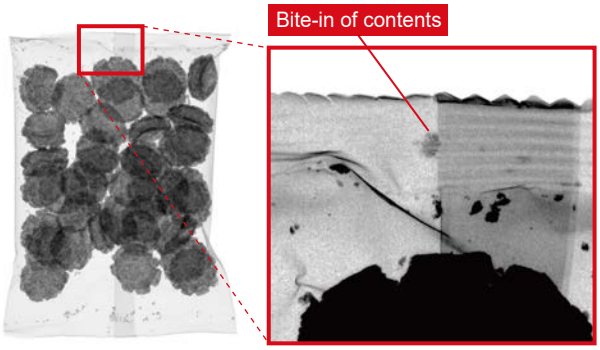
Sample: Fish slice
Detector: C12300-321B
Tube voltage: 50 kV
Magnification: 1.1 times



The C12300 series has a resolution of 48 µm/pixel, which enables even small bones in sliced fish to be observed at high resolution.

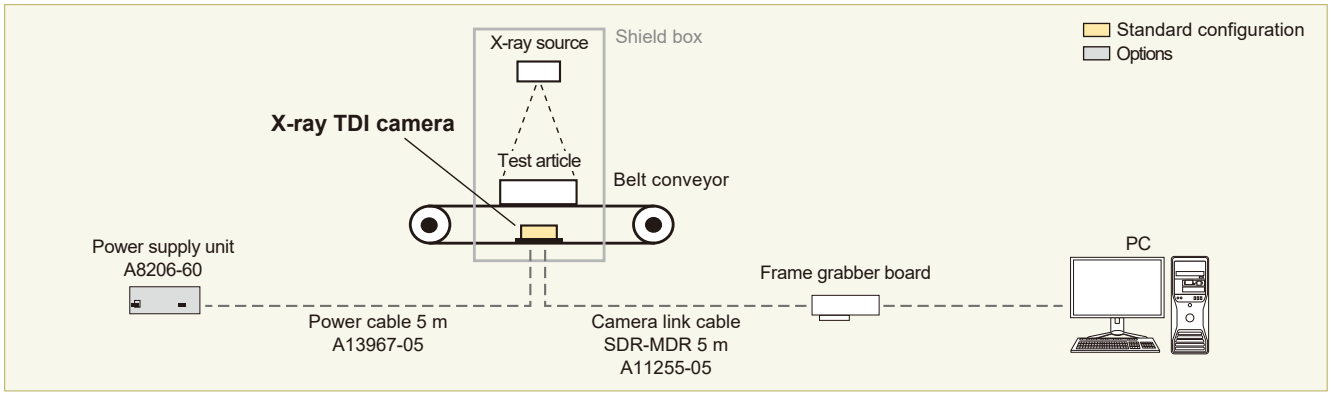
Inspection of package bite-in

Sample: Crackers
Detector: C12300-321B
Tube voltage: 30 kV
Magnification: 1.1 times



The C12300-321B has high sensitivity at the low tube voltage region. As a result, it can detect even bite-in of food packages that are difficult to generate contrast on.

System Configuration



* A standard configuration includes only the camera. The power supply unit, power cable, camera link cable and software API are available as the optional.
* When the C12300-461B is used, two camera link cables are required.
* The image display equipment (computer and frame grabber board), the X-ray source and shield box etc. should be prepared separately.

Options

Type number	Product name
A8206-60	Power supply unit
A13967-05	Power cable 5 m
A11255-05	Camera link cable SDR-MDR 5 m

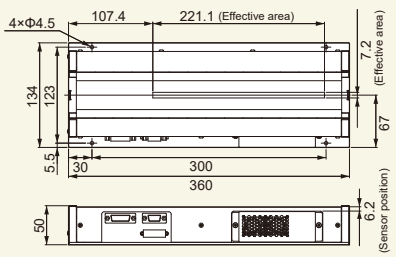
Software

●DCAM-API https://dcam-api.com/
Software API Support (Microsoft Windows)

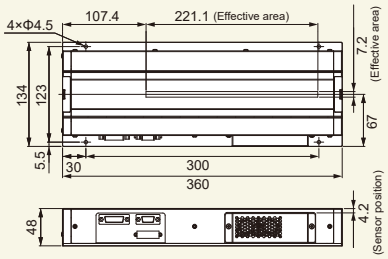
Dimensional Outlines (Unit: mm)

The housing can be designed to custom dimensions. For details, please contact your Hamamatsu representative or distributor.

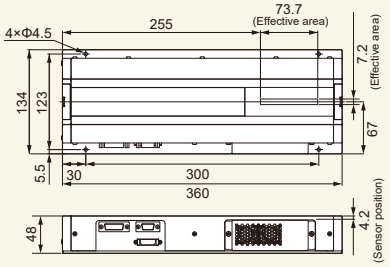
● **C12300-321, -321B (Approx. 4.4 kg)**



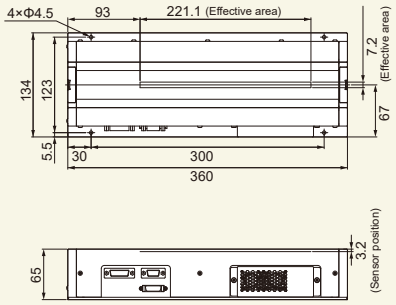
● **C12300-322 (Approx. 4.4 kg)**



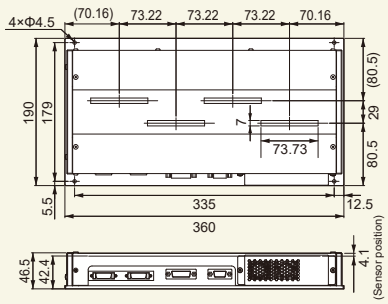
● **C12300-121 (Approx. 4.1 kg)**



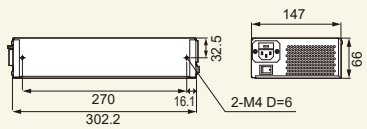
● **C12300-323 (Approx. 6.2 kg)**



● **C12300-461B (Approx. 8.5 kg)**



● **A8206-60 (Option) (Approx. 1.6 kg)**



- Product and software package names noted in this documentation are trademarks or registered trademarks of their respective manufacturers.
- Subject to local technical requirements and regulations, availability of products included in this promotional material may vary. Please consult your local sales representative.
- Information furnished by HAMAMATSU is believed to be reliable. However, no responsibility is assumed for possible inaccuracies or omissions.
  Specifications and external appearance are subject to change without notice.
- Please note the X-ray images on this brochure are taken for test purpose, the images do not reflect actual qualities of the products on the market.

HAMAMATSU PHOTONICS K.K. www.hamamatsu.com

Systems Division
812 Joko-cho, Higashi-ku, Hamamatsu City, 431-3196, Japan, Telephone: (81)53-431-0124, Fax: (81)53-433-8031, E-mail: export@sys.hpk.co.jp
U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, NJ 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218 E-mail: usa@hamamatsu.com
Germany: Hamamatsu Photonics Deutschland GmbH.: Arzbergerstr. 10, 82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8 E-mail: info@hamamatsu.de
France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10 E-mail: infos@hamamatsu.fr
United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court,10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, UK, Telephone: (44)1707-294888, Fax: (44)1707-325777 E-mail: info@hamamatsu.co.uk
North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 16440 Kista, Sweden, Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01 E-mail: info@hamamatsu.se
Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20044 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41 E-mail: info@hamamatsu.it
China: Hamamatsu Photonics (China) Co., Ltd.: 1201 Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R. China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn
Taiwan: Hamamatsu Photonics Taiwan Co., Ltd.: 8F-3, No.158, Section 2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)3-659-0080, Fax: (886)3-659-0081 E-mail: info@hamamatsu.com.tw

Cat. No. SFAS0034E04
NOV/2021 CR
Created in Japan