

OPTICAL PINHOLE INSPECTION UNITS



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Applying light to find pinhole defects during ongoing production of a vast range of materials and products

In recent years, the inspection process has become indispensable in all types of manufacturing. Hamamatsu optical pinhole inspection units find tiny pinhole defects to help manufacturers improve their product quality and reliability. Besides detecting pinhole defects, optical pinhole inspection units can also monitor drilling, boring and a host of other manufacturing processes.

Problems caused by pinholes

Liquid leaks

Quality degradation

Deformation and tears

Corrosion

Change in electrical characteristics

Contamination from foreign matter

Poor appearance

Applications

[Materials]

Accommodates a wide range of materials and products

Component and material examples


Metal



ex.

- Stainless steel
- Titanium
- Aluminum


Paper and nonwoven fabric



ex.

- Paper
- Milk cartons
- Masks
- Fabric

Semi-transparent materials



ex.

- Polyethylene
- Ceramic
- Teflon




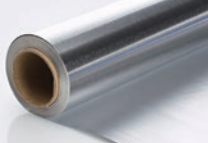
TOPICS

Degree of difficulty in detecting pinholes in semi-transparent materials

In optical pinhole inspection, the difficulty in detecting pinholes is vastly different between materials that let light pass through and those that don't let light pass through. The words semi-transparent or translucent are used to indicate materials that let light pass through them. Yet there is a vast array of such materials and the amount of light that passes through them differs in each type of material. Here we show you how the degree of semi-transparency to light affects the detection capability of our optical pinhole inspection units.



When you shine light onto the front side of a material, any material where you can still see that light from the rear side is called a semi-transparent material. Non-woven fabric such as in face masks and plain paper is semi-transparent. Actually, most non-transparent or opaque materials are metallic. A look at the detection principle on page 10 shows that pinhole defects can be found by detecting the light passing through the pinhole or by measuring the difference in the amount of light passing through the semi-transparent material. This means that the degree of difficulty in detecting pinholes depends on the surface roughness and irregularities, the flapping or fluttering of the workpiece, or conditions in the vicinity of the production line.

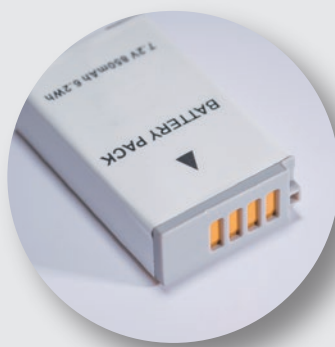
Material Image				
Light transmittance level	Transparent	Semi-transparent	Semi-transparent	Opaque
Detection difficulty	Undetectable	Difficult to detect	Not so difficult to detect	Easy to detect
Amount of transmitted light	Almost all light passes through	Large amount of light passes through	Small amount of light passes through	No light passes through
Specific example	Glass, transparent film	Polyethylene, ceramic	Paper, non-woven fabric, membrane	Metal

Sealed and molded product examples

Beverage cans and can lids



Aluminum battery pack



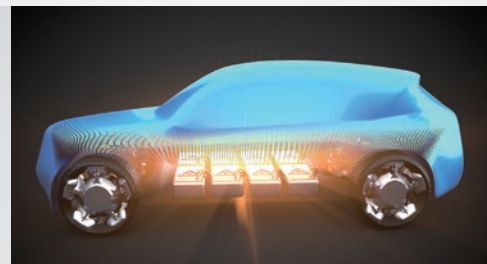
Aluminum blister pack



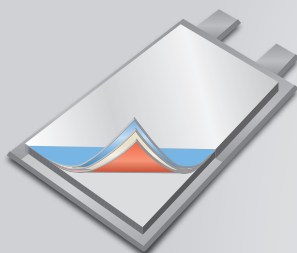
TOPICS

Pinhole inspection of in-vehicle products

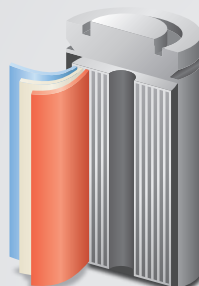
Ongoing technological innovations in electric vehicles and fuel cell vehicles are making constant progress in achieving higher performance, lower costs, and greater mass production. Our pinhole inspection units contribute to high-precision quality control and high speed in production of lithium-ion batteries and fuel cells that are core components of vehicle power sources.



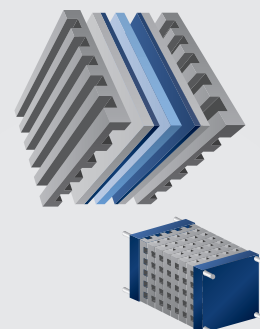
**Lithium ion rechargeable battery
[pouch type]**



**Lithium ion rechargeable battery
[cylindrical type]**



Fuel cell



The "cell" that stores the energy of the rechargeable battery utilizes a flammable electrolyte that easily reacts with oxygen. So this "cell" must be hermetically sealed to totally prevent leakage even including evaporative gas. Our optical pinhole inspection units are ideal for achieving high-precision inspections that ensure reliable hermetic sealing.

Features

[Comparison with other methods]

High-speed detection



We can provide the optimal unit to match your production line.

Non-contact



Samples are not exposed to specific environments such as electric fields, magnetic fields and electrolyte or liquids that induce material stress.

Highly accurate detection






High-sensitivity optical sensors* ensure high-precision inspections

* Our optical pinhole units use photomultiplier tubes or opto-semiconductor sensors we manufacture in-house at our facility.




Other features

- Self-diagnostic function: Checks detector operation to allow high-reliability inspections.
- Protection circuit: Minimizes damage to detector even when exposed to excess light.

	Hamamatsu optical pinhole inspection units 	Visual inspection 	Camera inspection 
Detection capability	A High detection capability	D	B
Type of workpiece for inspection	B Accommodates a wide range of workpieces	D	B
Production line speed	A Accommodates high-speed conveyors	D	C
Size of workpiece for inspection	B Accommodates a wide range of sizes	B	C
Initial cost	C Low cost compared to using cameras	B	D
Running cost	B Only power costs are required	D	C
Position and size judgment	D Impossible	C	A

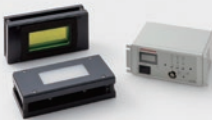

Product lineups

Feature comparison [for inspection of films]

	C12190	C12570	C12760
			
Detection capability	30 μm	2 μm	10 μm
Compatible line speed	600 m/min	30 m/min	600 m/min
Compatible line width ^①	1800 mm	450 mm	50 mm
Compatible films	Opaque films only	Opaque films only	Compatible with semi-transparent films

① Compatible width per inspection unit

Feature comparison [for inspection of molded / formed products]

	C11750	C16510
		
Compatible workpiece	Various molded / formed products	Cans only
Detection capability	5 μm	10 μm
Inspection method	Intermittent inspections (Workpiece is clamped for each inspection)	Continuous inspections
Inspection speed	0.5 s/time	2400 pieces/min
Compatible workpiece size	Customizable	Cans only

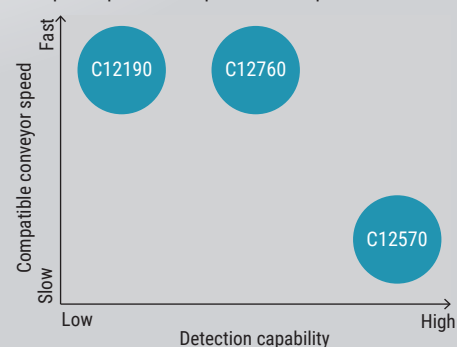
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Conveyor speed and detection capability

Production line conveyor speeds that our pinhole inspection units can handle differ for each model. Each model has a fixed conveyor speed regardless of the target pinhole size to detect.

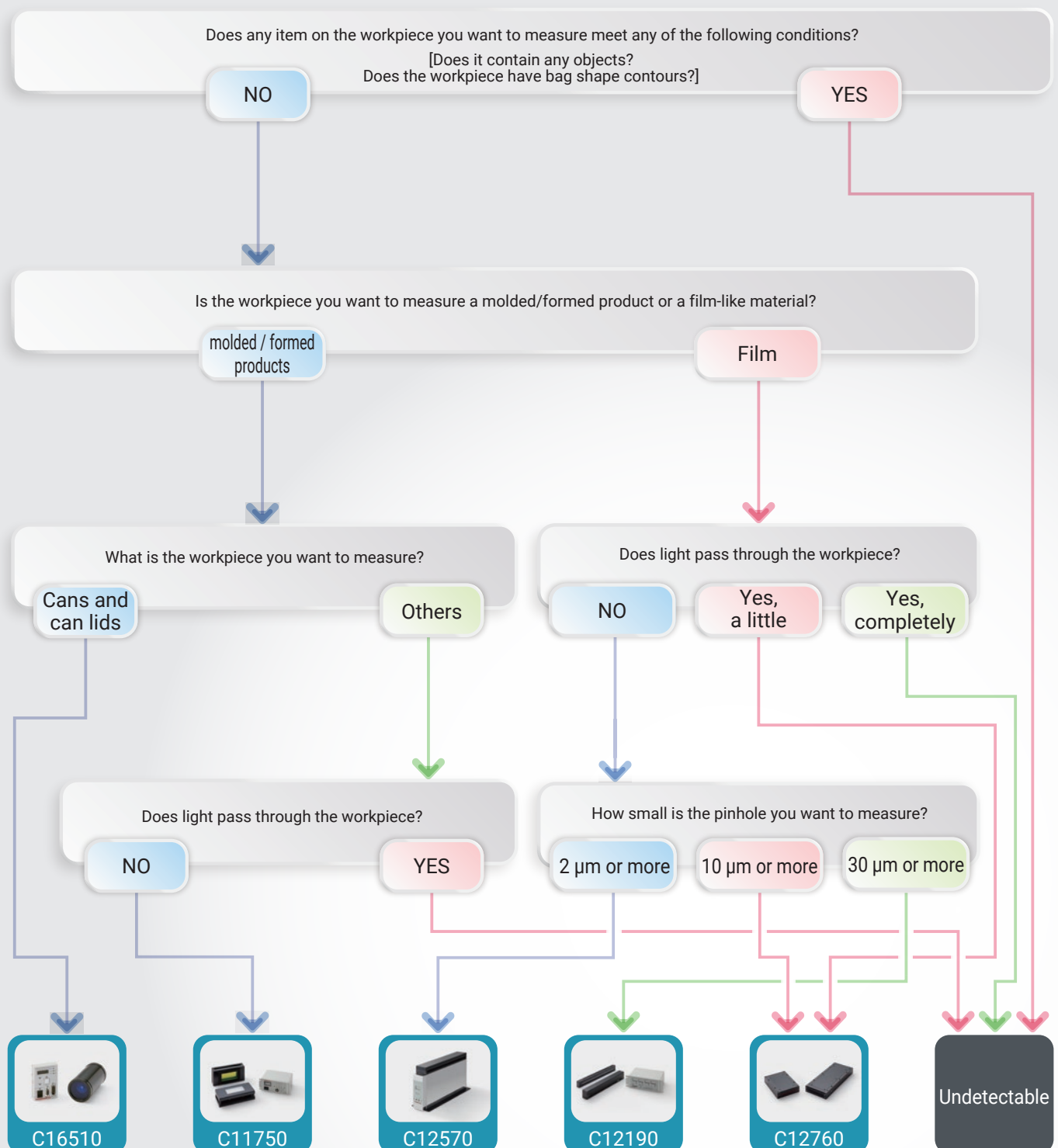
For example, the C12570 can detect pinholes of 2 μm on a conveyor line moving at a maximum speed of 30 m/min. However, if the conveyor speed is faster than 30 m/min, we cannot guarantee that pinholes will be detected no matter how large the pinhole size is. Conversely, detection capability will not increase even if the C12570 is used at conveyor speeds slower than 30 m/min.

● Optical pinhole inspection unit performance on films



How to select

[Flowchart for selecting an optimal unit]



Workpiece compatibility quick reference

For roll-to-roll materials

Type No.	Target materials			
	Metal films	Semi-transparent materials		
		Paper	Cloth, nonwoven fabric	Rechargeable battery separators
C12190	✓	—	—	—
C12570	✓	—	—	—
C12760	✓	✓	✓	✓

For molded / formed products

Type No.	Target materials			
	Fuel cell separators	Battery packs	Cans and can lids	Blister packs
C16510	—	—	✓	—
C11750	✓	✓	—	—
C12570	—	—	—	✓

TOPICS

We can evaluate your workpiece samples!

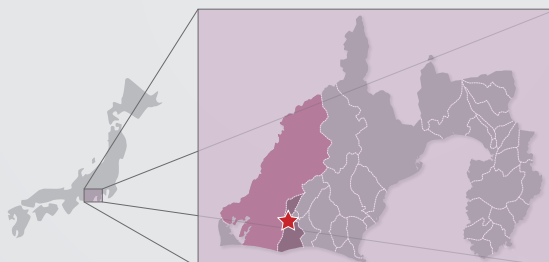
To confirm whether pinhole defects in workpieces to inspect can actually be detected, we provide a simple demo unit for demonstrating pinhole detection. If you'd like us to evaluate your workpiece samples, please feel free to contact us by way of our website.



When you want us to find optimal conditions for pinhole detection setup during this evaluation, we recommend sending us the actual workpiece sample. If circumstances make it difficult to get an accurate evaluation at our Toyooka factory (Electron Tube Division), we can lend a demo unit for evaluation at your site. In that case, please give us the following information which will help us quickly prepare a demo unit.

Please give us the following information:

- Type, shape, material of workpiece
(whether light passes through it or not)
- Conveyor system
(roll-to-roll, batch processing)
- Pinhole diameter to detect
- Preparation of workpiece samples



Detection principle

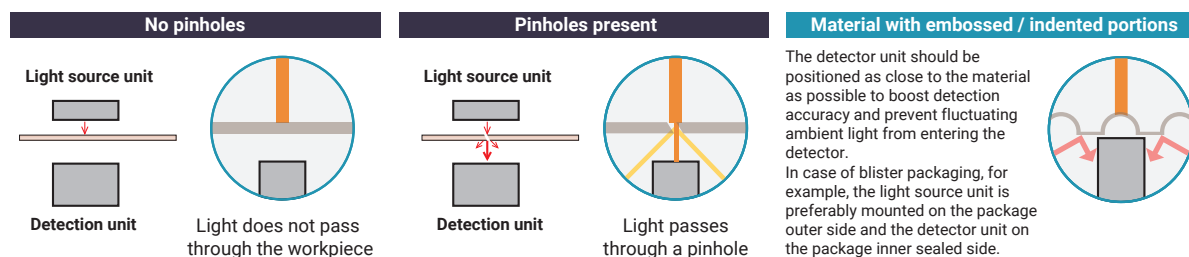
•Pinhole judgment

Hamamatsu optical pinhole inspection units allow setting the pinhole judgement threshold to any desired level. Inspection units judge light exceeding the threshold level as a pinhole.

- ① Irradiates workpiece with light that is linearly shaped along the workpiece width.
- ② Detects light scattering at pinhole or passing through workpiece.



[Light impervious material] Detecting light that passes through a pinhole



[Semi-transparent material] Detecting light that passes through a pinhole (Applicable products: C12760)



C12760



Minimum detectable pinhole size

10 μm

Detection width (per unit)

50 mm

Maximum detection speed

600 m/min

Highly versatile and even compatible with semi-transparent workpieces.
Compact design allowing parallel multi-unit operation.

Parameter	Description / Value	Unit
Input voltage (DC)	24	V
Detection unit	Detector	Photodiode array
	Maximum current consumption	0.1 A
	Detection width	50.8 mm
Light source unit	Light source / Wavelength	Laser diode / 660 nm
	Maximum current consumption	0.1 A
	Maximum energy output	5 mW
	Laser class	3R (IEC60825-1)
Operating temperature range	+10 to +40	°C
Storage temperature range	-20 to +50	°C
Operating / storage humidity range ^①	35 to 85	%RH
Applicable standard	IEC61326-1: Group 1 Class A IEC60825-1: Class 3R laser product	—

① Light condensing unit and light source unit can be customized to match your application.

CLASS 3R LASER

Invisible Laser Radiation: Avoid Direct Exposure of eyes to Beam

● The Laser emits invisible laser radiation.

The instrument which used the LASER, operated under ordinary conditions, is classified as Class 3R according to the laser product classification code IEC 60825-1.

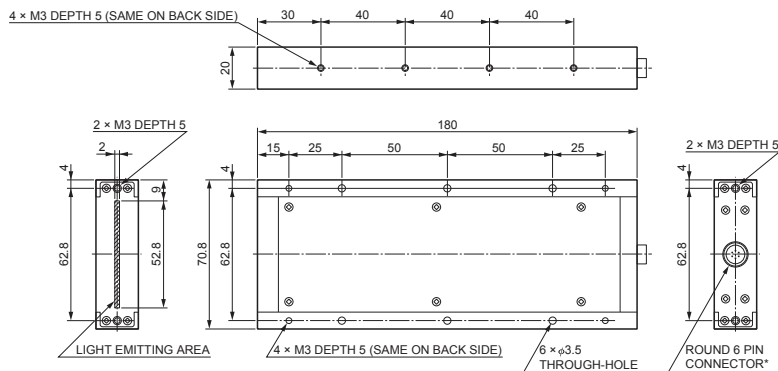
See IEC 60825-1 for more details and safety operation concerning the above countermeasures.

* Accessories: Detection connector socket, light source connector socket

Dimensional outline

● Light source unit

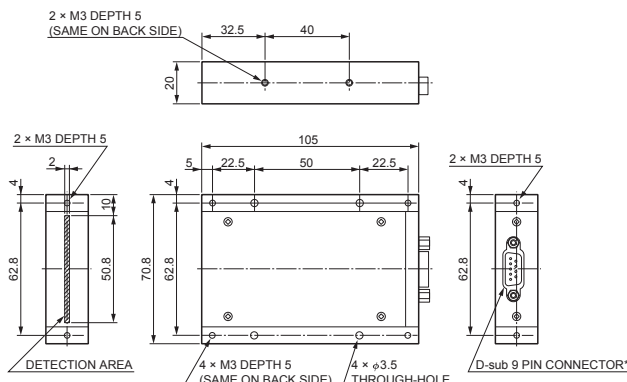
(Unit: mm)



* C12760 includes a round 6 pin connector (HIROSE HR10A-7P-6P(73)). Please prepare a cable between connector and PLC because it is not attached with C12760.

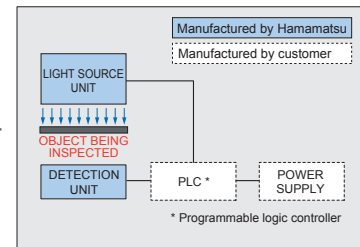
Weight: 0.36 kg

● Detection unit



* C12760 includes a D-sub 9 pin connector (OMRON XM3D-0921 and hood XM2S-0921). Please prepare a cable between connector and PLC because it is not attached with C12760.

Weight: 0.21 kg





C12570

Minimum detectable pinhole size
2 μm

Detection width (per unit)
450 mm

Maximum detection speed
30 m/min

High detection capability.
Light source position and detection width are selectable to match your application.

Parameter		Description / Value			Unit
Suffix		-01/-11	-02/-12	-03/-13	—
Input voltage (DC)		24			V
Maximum current consumption		0.8			A
Detection unit	Detector	Photomultiplier tube			—
	Detection width	304.8	152.4	457.2	mm
	Number of channel	2	1	2	—
Light source unit	Light source / Wavelength	LED/644			nm
Operating temperature range		+10 to +40			°C
Storage temperature range		-20 to +50			°C
Operating / storage humidity range ^①		35 to 85			%RH
Applicable standard		IEC61326-1: Group 1 Class A			—

① No condensation

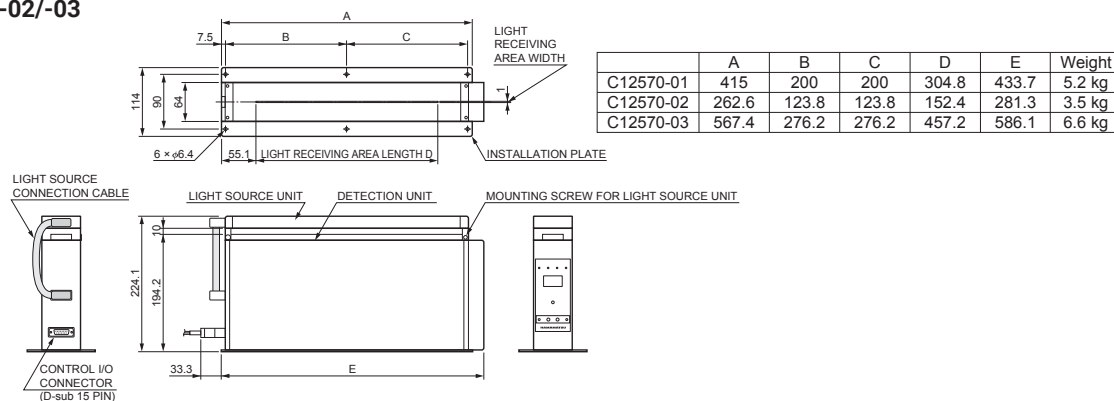
* Detection pinhole size depends on light intensity and installation environment.

* Accessories: I/O socket, light source cable (0.3 m), pinhole plate, optical pinhole (2 μm dia.)

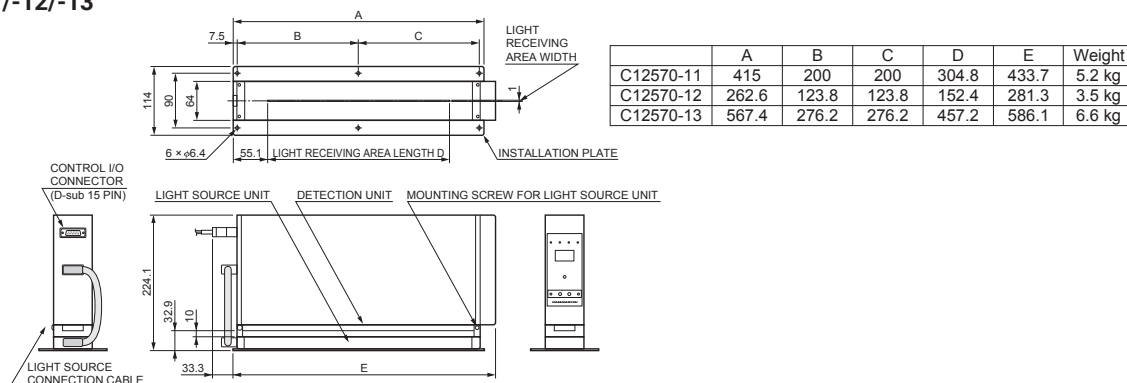
Dimensional outline

(Unit: mm)

●C12570-01/-02/-03



●C12570-11/-12/-13



C12190



Minimum detectable pinhole size
30 μm

Detection width (per unit)
1800 mm

Maximum detection speed
600 m/min

Judges pinholes by grouping into 4 sizes.
Sensitivity and detection width are selectable to match your application.

Common specifications

Parameter	Description / Value	Unit
Input voltage (DC)	24	V
Detection unit	Detector	—
	Number of channels ^①	4
Operating temperature range	+10 to +40	°C
Storage temperature range	-20 to +50	°C
Operating / storage humidity range ^②	35 to 85	%RH
Applicable standard	IEC61326-1: Group 1 Class A	—

Standard type

Parameter	-01	-02	-03	-04	-05	-06	Unit
Detection pinhole size ^③	50 μm to 2 mm						—
Detection width	304.8	609.6	914.4	1219.2	1524	1828.8	mm
Detection unit ^④	Maximum current consumption	0.75	0.8	0.85	0.9	0.95	A
Light source unit	Light source / Wavelength (Typ.)	LED / 644					nm
	Maximum current consumption	0.18	0.36	0.54	0.72	0.9	A

High sensitivity type

Parameter	-11	-12	-13	-14	-15	-16	Unit
Detection pinhole size ^③	30 μm to 1 mm						—
Detection width	304.8	609.6	914.4	1219.2	1524	1828.8	mm
Detection unit ^④	Maximum current consumption	0.75	0.8	0.85	0.9	0.95	A
Light source unit	Light source / Wavelength (Typ.)	LED / 940					nm
	Maximum current consumption	0.3	0.6	0.9	1.2	1.5	A

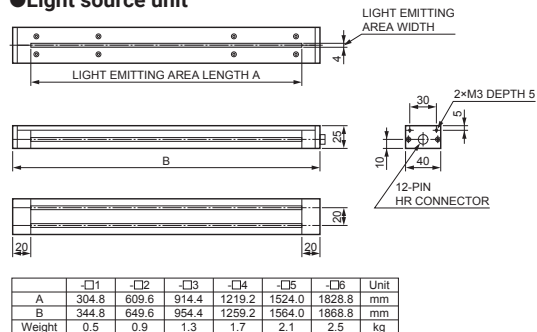
① Detection width is equally divided into each channel. ② No condensation

③ Detection pinhole size depends on light intensity and installation environment. ④ Values when used along with control unit.

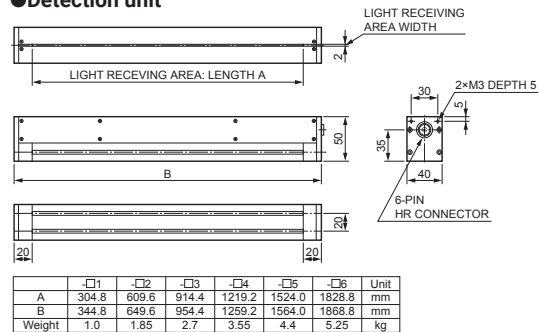
* Accessories: Light source connection cable (10 m), detection cable (10 m), I/O socket, pinout connector, Light source power connector

Dimensional outline

●Light source unit

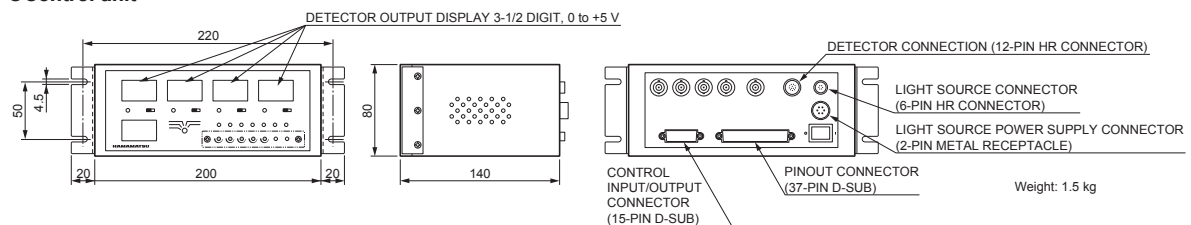


●Detection unit



(Unit: mm)

●Control unit



C11750

Minimum detectable pinhole size
5 μm

Inspection time
~0.5 s

Detection area
Customizable

Light condensing unit can be customized to match your specific application.
Compatible with large-area workpieces.

Parameter	Description / Value		Unit
Input voltage (DC)	24		V
Maximum current consumption	0.5		A
Light condensing unit	Type No.	A12159-01 (sold separately) ①	—
	Wavelength	470	nm
Light source unit	Type No.	L12057-01 (sold separately) ①	—
	Wavelength	470	nm
Operating temperature range	+10 to +45		°C
Storage temperature range	-20 to +50		°C
Operating / storage humidity range ②	35 to 85		%RH
Applicable standard	IEC61326-1: Group 1 Class A		—

① Light condensing unit and light source unit can be customized to match your application.

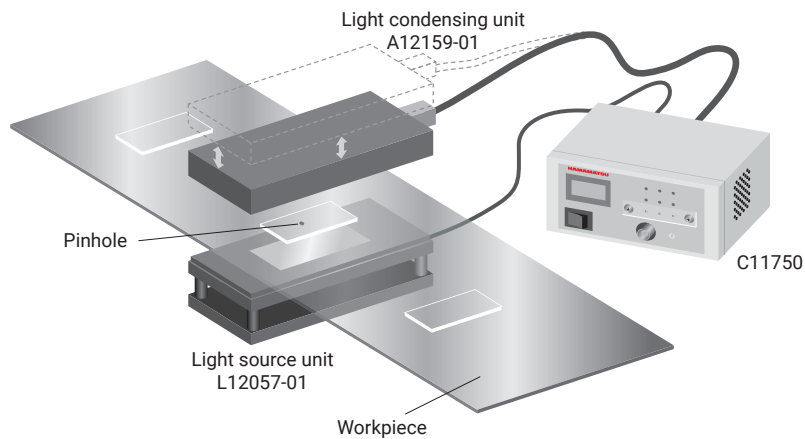
② No condensation

* Detectable pinhole size depends on workpiece shape and equipment configuration.

* Information on I/O socket connections and recommended operation flowchart is available.

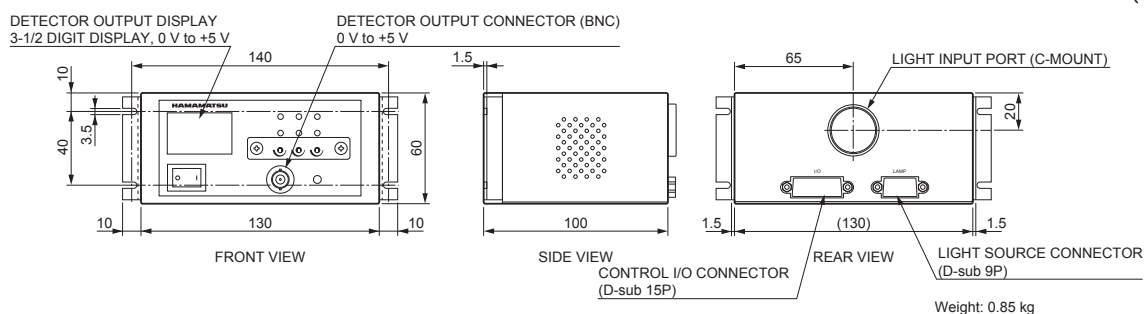
* Accessories: I/O socket, light source socket

Detection configuration example



Dimensional outline

(Unit: mm)





C16510

Minimum
detectable
pinhole size
10 μm

Maximum
detection speed
2400 pcs/min

Designed specifically for inspection of cans.
Can be used with equipment for inline inspections.

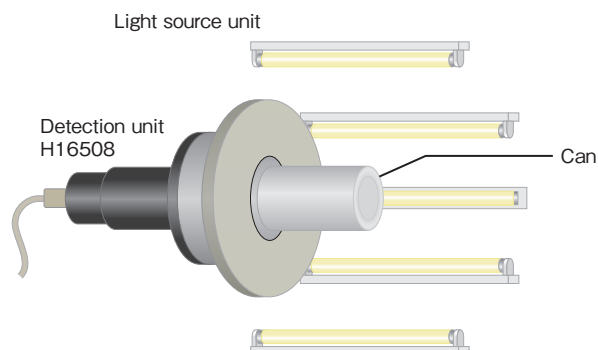
Parameter	Description / Value	Unit
Input voltage (DC)	24	V
Maximum current consumption	0.1	A
Detection unit	Detector	Photomultiplier tube
	Photosensitive area size	$\Phi 54$
	Wavelength range	450 to 480 nm
Operating temperature range	+10 to +45	$^{\circ}\text{C}$
Storage temperature range	-20 to +50	$^{\circ}\text{C}$
Operating / storage humidity range ^①	35 to 85	%RH
Applicable standard	IEC61326-1: Group 1 Class A	—

① No condensation

* Detectable pinhole size depends on can shape and irradiation light level.

* Accessories: Flange ring, I/O cable, PH300 cable

Detection configuration example

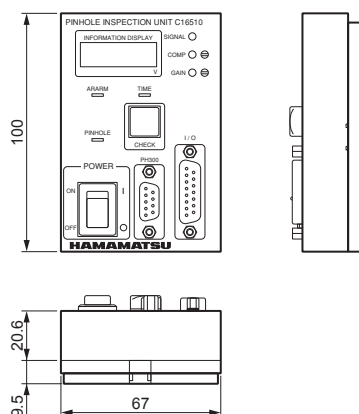
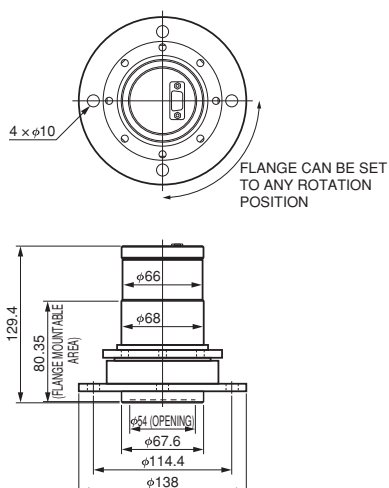


Dimensional outline

Detection unit H16508

Control unit C16509

(Unit: mm)



Q & A

Q Is it possible to find the pinhole positions, number of pinholes, and sizes?

A A single detector has only a limited detection range so cannot find the positions, number of pinholes, and sizes. However, if you use multiple detectors to cover different detection ranges, you can gain information on the approximate positions and number of pinholes.

Q Can you assess and evaluate workpiece samples?

A Yes, we can usually make evaluation tests of sheets, films, Cans and can lids, molded parts, etc. Using one of our optical pinhole inspection units, we can assess, evaluate and issue a report of samples you send us. Though the exact turnaround time may vary according to the sample, making an evaluation usually takes about 2 weeks.

Q We want to use an optical pinhole inspection unit on production lines or inside equipment. How is it compatible with drive systems and control systems? Can it be installed and used in our current equipment?

A Basically, we ask that customers make the setups for the drive systems for the production lines and the control systems for the pinhole inspection unit. If you want to use our unit inside your current equipment or on your production line, then we will select the optimal product to match your line configuration. Please feel free to consult us.

Q Do optical pinhole inspection units have to be in a dark room to work properly?

A Our optical pinhole inspection units can operate in a room with normal lighting. However, in some cases, it may be necessary to block out ambient light around the detector depending on the type of product or usage method.

Q When you say “semi-transparent materials” what do you actually mean?

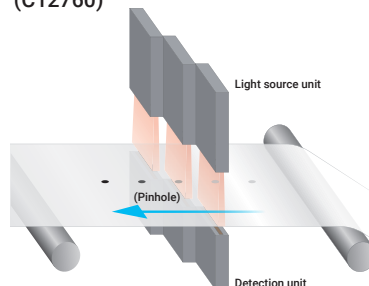
A At Hamamatsu Photonics, we use the term “semi-transparent materials” to refer to any materials that allow even a tiny amount of light to pass through them. The higher the transparency, the more difficult to detect pinholes. Some typical materials are listed on page 4, so please have a look at them.

Q Some workpieces we want to inspect are very long along their width. Can these be inspected also?

A Workpiece width compatible with our optical pinhole inspection units varies according to the product. See the following table.

Model No.	Compatible?	Method
C12570	Yes	Use multiple units in a staggered arrangement
C12190	Yes	
C12760	Yes	
C11750	Yes	Use a customized design of light condensers and detectors to match the workpiece width
C16510	No	Unusable (designed only for specific molded/formed products)

Staggered arrangement example (C12760)



Q Are there any precaution to take when using with equipment?

A For example, if a film-like workpiece is to be inspected, then it might flutter or flap around during conveying which causes false or faulty detection. In that case, you must take whatever methods needed such as clamping the workpiece on the production line to reduce flutter or flapping as much as possible. You may need to take other precautions depending on the workpiece or conveyor configuration, so please consult us for assistance.

Q What types of workpieces are impossible to inspect?

A Pinholes cannot be detected if contents are sealed inside, or workpiece has a bag shape or is completely transparent. Detection is also impossible if the faulty point on the workpiece is so tiny that it exceeds the detector's capabilities. Also, though not totally impossible, the following items are difficult to inspect under certain conditions.

Material through which light passes: Printed materials, non-planar shaped materials, and highly transparent materials.
Material impervious to light; Complex-shaped materials, rubber materials

The result (pass/fail) is determined by making an evaluation of an actual sample workpiece.

Q Is it possible to raise the detection speed and detection performance?

A It is not possible to boost detection speed or detection capability higher than the product specifications of pinhole inspection units. However, detection performance is determined by evaluating an actual sample workpiece. If the workpiece is a good match with the pinhole inspection unit to be used, then detection performance might be higher than the value listed in the catalog.

Q Does the detection accuracy change with the workpiece conveyor speed?

A There is no change in accuracy if kept within the maximum detection speed.

Q What type of light source is used?

A An LED or laser diode is used as the light source, depending on the pinhole inspection unit. See the product description pages (pages 11 to 15) for detailed information on each product.

Q If false or faulty detection occurs during inspection, what are some likely causes?

A False detection tends to occur when ambient light around the detector is not being blocked well enough. So most false detections can be prevented by installing light shielding around the measurement points. Our engineers can offer advice on light blocking measures based on the past records of problems and solutions. Also in rare cases, false detection occurs due to reasons other than light blocking problems. Feel free to consult us about any detection problems that occur after you receive the optical pinhole inspection unit.

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