

Image sensors

This document describes general precautions for using Hamamatsu image sensors (hereafter called "the product"). For precautions on handling surface mount type products and unsealed products (opto-semiconductors whose chip is exposed), refer to precautions for "surface mount type products" and precautions for "unsealed products" available from Hamamatsu, respectively.

If the precautions are described in the delivery specification sheet, be sure to strictly comply with those instructions.

1. Handling

(1) Dust, contamination and scratch countermeasures

Electrical and optical characteristics may deteriorate if dust, contamination, or scratches are on the light input window of the product, so take the following precautions:

- Perform work in a clean location.
- If the product is dropped or if strong friction is applied to the light input window, the light input window may be scratched. So, be sure to handle the product with great care.
- Never attempt to disassemble or modify the product. Otherwise, the product may malfunction. When touching the product, it is recommended to wear gloves or use tweezers. In particular, do not touch the light input window with bare hands. Contamination on the light input window may cause the transmittance to decrease. In the case of ultraviolet light detection, oil from the fingers can cause a 30% drop in sensitivity. Moreover, touching the leads with bare hands may cause leakage between terminals or plating corrosion, or problems with solder wettability.
- Do not allow sharp or hard objects to come in contact with the window to prevent it from being scratched. In particular, resin sealed (potting or coating) types, plastic packages, and types with an anti-reflection coated window are vulnerable to scratches, so handle them carefully. If very small light spots are detected, then scratches on the window may be a problem.
- Take precautions to protect the window from contamination or scratches when packing or shipping equipment in which the product is installed.

(2) Removing Contamination

- If dust is adhering to the window, blow it away with a blow gun. Use an ionizer along with the blow gun to remove static electricity.
- If oil or grease adheres to the window, then gently wipe it away with cotton swabs, etc. moistened with ethyl alcohol so that the window is not scratched. Rubbing strongly or wiping the same section

over and over will decrease the electrical and optical characteristics, or the reliability.

- Do not rub the window with a dry cloth or cotton swab. Doing so may cause scratches or static electricity, resulting in malfunctions.
- Absolutely never use solvent for cleaning.

(3) Precautions when mounting

- The product is a precision optical component, so placing excessive loads on the package may cause problems such as package warping or damage, chip peeling, wire breakage, damage to thermoelectric cooler, or poor optical characteristics. Take full precautions when mounting the product on the board, inserting the product into the socket, or installing the heatsink.
- Never handle the product in the following ways since this may cause the package to break.
 - push the product wire leads into the socket forcibly with high insertion pressure.
 - apply a hot soldering iron to the leads for a long time.
 - apply repeated stress to the leads.
 - suddenly cool or suddenly heat the product.
 - for thermoelectrically cooled image sensors, put thermo conductive materials with uneven thickness between the sensor and heatsink, and tighten them excessively.
- Check the pin connection positions when mounting the product in the socket. Installing the product reversely or in the wrong position may damage the product. Be sure to turn on the power after the product has been properly installed.
- Never push the light input window when inserting the product onto the printed circuit board, etc. Pushing the light input window may cause cracks and fractures in the light input window, possibly causing it to fall out. This may lead to malfunctions.
- When handling the product, hold its side surfaces as shown in Photo 1.
- The product can also be inserted by pushing its screw fixing parts at both ends as shown in Photo 2, but pushing too strongly may cause the screw fixing parts to break, so do not push them forcibly.
- Never push the product surface with your fingers, hands, or tools as shown in Photos 3 and 4.
- When connecting the product to the socket, use a socket that conforms to the product wire lead specifications. Additionally, do not forcibly insert the product with bent wire lead. (Doing so may apply strong stress to the package.)
- Be aware that inserting the product reversely, inserting it incorrectly, or causing short-circuit between terminals may lead to malfunctions.

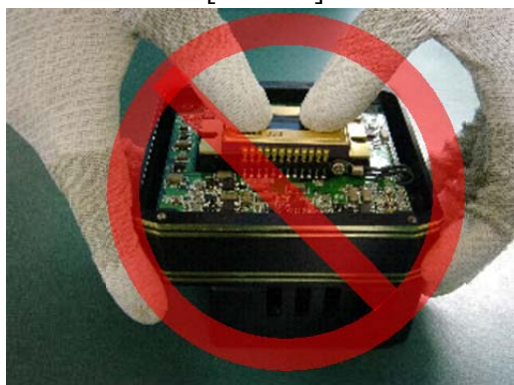
[Photo 1]



[Photo 2]



[Photo 3]



[Photo 4]



(4) Incident light level

- The product output is proportional to the incident light saturation exposure (incident light level × integration time). The electrical charge that can be accumulated in the image sensor is limited, so signals higher than the saturation charge cannot be read out. Oversaturation charges can cause a blooming phenomenon and may adversely affect the characteristics temporarily. Set the integration time so that the output is not saturated.
- Do not expose the product for long periods of time to strong light that exceeds normal operating conditions.

(5) Ultraviolet light and X-ray irradiation

- Long-term exposure to the UV or X-ray irradiation will cause product characteristics to deteriorate. Avoid exposing the product to any unnecessary UV or X-ray irradiation. The product usage environment may require countermeasures to block unnecessary UV or X-rays. Please avoid exposing the bonding sections of the ceramic base and glass to UV light.

(6) Cooling/heating temperature gradient rate

- Make the setting so that the temperature does not change suddenly during element cooling or heating.

(7) Usage in high temperature/humidity environments

- Product deterioration is faster at high temperature and humidity than at normal temperature and humidity. Avoid using the product in high temperature/humidity environments unless absolutely necessary.

2. Storage

- Do not let the product get wet or be exposed to direct sunlight, harmful gases, or dust. Also avoid storing it in locations where sudden temperature changes may occur.
- For products packed in moisture-proof bags, do not open the bag until just before product use so as to prevent oxidation or contamination on the leads and moisture absorption by the package. Even if still packed in the moisture-proof bag, do not let the bag get wet or be exposed to direct sunlight, harmful gases or dust, or do not store it in locations where sudden temperature changes may occur. Also avoid humidity rise which may occur such as by turning off the night-time air conditioning.
- Do not lay a heavy object or load on the product or the bag. Also avoid stacking the products or bags

when storing them.

- If storing the product in another case, then use a container not easily charged with static electricity. If the product is an electrostatic sensitive device, then place it in a conductive case.
- Placing the product in an unsatisfactory environment (exceeding recommended storage conditions [Table 1]) may cause poor solderability, rust on product leads, or a drop in electrical characteristics. If there are storage conditions listed on the datasheet or delivery specification sheet, then be sure to comply with them.
- For products packed in moisture-proof bags, if there is a problem with the sealing of the moisture-proof packing, then the silica gel color will change from navy blue to red due to moisture absorption. So, check for color change of the silica gel when opening. If any fault is found, contact Hamamatsu.
- For tape packing products, tape unwound from a reel must not be left in that state for long periods. Additionally, do not bend the tape more than necessary.

[Table 1] Recommended storage conditions

Product		Storage conditions	Remark
Product not packed in moisture-proof bag		Temperature: 15 °C to 35 °C Humidity: 45% to 75%	
Product packed in moisture-proof bag	Unopened product	Temperature: 15 °C to 35 °C Humidity: 45% to 75% Period: within 12 months	A sharp item coming in contact with the moisture-proof bag might open a hole in it, so use caution.
	Opened product	Temperature: 15 °C to 35 °C Storage in a low-humidity desiccator Period: within 3 months	

3. Soldering

The correct soldering time and temperature differ depending on the type of package. See the recommended soldering condition examples [Table 2] for soldering time and temperature. If soldering conditions are listed in the datasheet or delivery specification sheet, then please comply with those conditions.

[Table 2] Recommended soldering condition examples

Package	Soldering temperature	Soldering time	Remarks
Metal	260 °C or less	Within 10 seconds	
Ceramic	260 °C or less	Within 5 seconds	Solder the leads at a point at least 2 mm away from the package body.

(1) Points requiring special caution

- Take adequate care to make sure that the soldering iron tip temperature and the soldering time are correct.
- Do not attempt soldering at high temperatures or long periods.

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- Take measures to prevent solder or flux from flying outward and sticking to the light input window, contaminating it.

(2) Flux

Use non-cleaning solder or rosin type flux. Using flux with relatively strong acid or alkali levels or inorganic flux may cause corrosion on the leads.

(3) When using a soldering iron

- To prevent effects from electrostatic charges, use a grounded soldering iron whose insulation resistance is 10 M Ω or more.
- Set the soldering iron tip temperature by referring to the recommended soldering condition examples [Table 2]. If you cannot provide these conditions, then grip the root of the lead you are soldering with tweezers or a similar tool to prevent heat from conducting to the product package.
- Do not let the soldering iron directly contact the package section of the product. Direct contact with the soldering iron may cause mechanical or optical damage.
- Do the soldering so that no stress is applied to the package section of the product. Soldering in a state where stress is applied will cause residual stress after the soldering that tends to cause deterioration.

(4) Soldering of bump connection products

- Use a solder paste suitable for components with fine pitch leads or terminals.
- Before making bump connections, design a process by taking factors such as the solder paste, underfill resin, temperature conditions, and warping of the board due to heating into consideration.
- If the packing is opened and the product is left in that state for an extended period of time, the oxidation will develop on the bump surfaces, causing solder not to melt. So, mount the product as quickly as possible after opening the packing.

4. Electrostatic sensitive devices

Electrostatic sensitive products such as CCD come with an electrostatic warning label on the product packing. Handling of the product requires taking precautions on the following points to avoid damage and product deterioration due to static electricity.

[Figure 6] Electrostatic warning label



(1) Workplace and facilities, etc.

- Lay a conductive mat (750 k Ω to 1 G Ω) on the surface of the workbench and ground it.
- Use conductive flooring material or lay a conductive mat on the workplace floor and ground it.

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- Ground all manufacturing equipment and inspection devices.
 - Keep moisture at approximately 50%. Low humidity tends to cause static electricity and high humidity is prone to moisture absorption.

(2) Handling

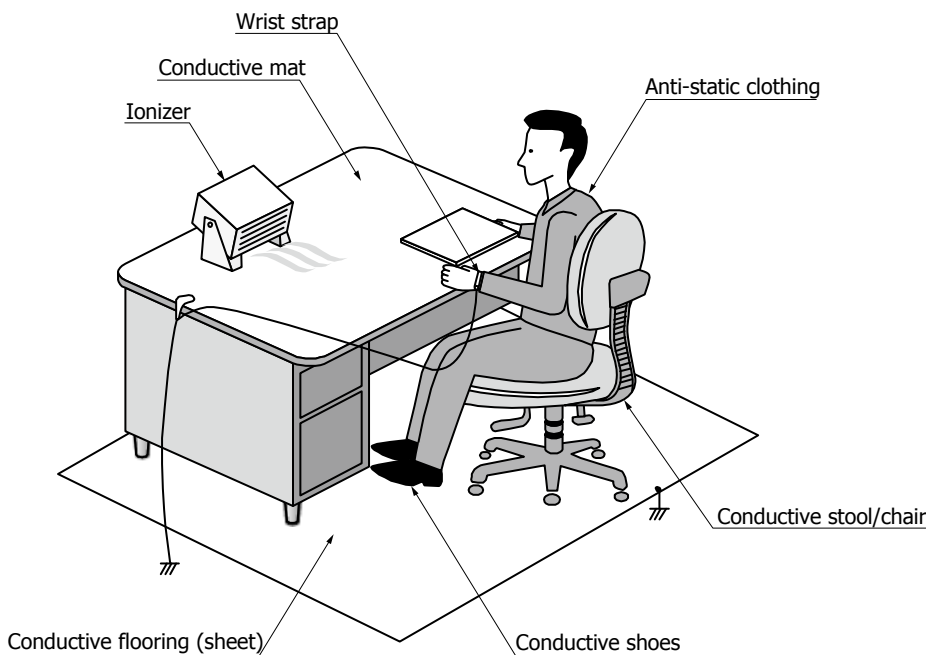
- Using an ionizer or similar item to eliminate electrical charges is recommended when handling the product.
- Wear anti-static clothing and conductive shoes (100 k Ω to 100 M Ω).
- Attach a wrist strap (having protective resistance of 750 k Ω to 35 M Ω) directly to the skin, and ground the strap. If the wrist strap does not include protective resistance, there is a risk of electric shock hazard due to electric leak. Also wear conductive finger sacks or gloves.
- Tools such as tweezers used to handle the product may sometimes become electrically charged. Connect a ground line as needed.
- Use a soldering iron with an insulation resistance of 10 M Ω or higher. The soldering iron tip should be grounded.
- If the product is induction-charged and contacts with a metal, excessive current may flow due to electrostatic discharge causing damage to the product. To prevent induction charging, keep objects (insulators such as plastic and vinyl, PC display monitors and keyboards, etc. that may possibly be electrically charged) away from the product. The product may be induction-charged even by just bringing such objects close to the product. If keeping such objects near the product is unavoidable, then use an ionizer, etc. to remove electrostatic charges from the objects that are apt to be electrostatically charged.
- Friction on the product causes electrostatic charges. If such friction is unavoidable, then remove the electrostatic charges using an ionizer, etc.
- Peripheral devices must be properly grounded so that no surges are applied to the product by a leakage voltage. Do not allow a voltage exceeding the absolute maximum ratings to be applied to the product from the measurement instrument, etc. (This tends to occur during ON/OFF switching of power sources, so use caution.) If there is the possibility of a surge voltage, insert a filter (made up of a resistor and capacitor) to protect the product. During operation do not attach or detach any connector, etc. that are connected to the power supply line or output line.

(3) Carrying, storage and packing

- Place the product on a conductive foam by inserting the leads into the foam (for shorting leads) and then put it in a conductive case. The PC board to mount the product should also be put in a conductive case. Also, avoid using plastic or styrofoam as they may generate static electricity by vibration during shipping, etc. causing breakdown or deterioration of the product.
- Use a conductive carrying case and storage shelf.
- Avoid storing the product near equipment that may generate high voltage or high electromagnetic fields.

Note: It is not always necessary to provide all the anti-electrostatic measures stated above. Implement these measures according to the extent of deterioration or damage that may occur.

[Figure 2] Electrostatic countermeasure example



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5. Precautions by product

Thermoelectrically cooled image sensor

(1) Heat dissipation

- If the thermoelectric cooler does not radiate away sufficient heat, then the product temperature will rise and cause physical damage or deterioration to the product. Make sure there is sufficient heat dissipation during cooling. As a heat dissipation measure, we recommend applying a high heat-conductivity material (silicone grease, etc.) between the product and the heatsink.
- When using a resin-based material such as silicone grease, apply it uniformly over the entire area where the image sensor touches the heatsink. Do not use old silicone. (If the silicone becomes old, the viscosity increases and the application with a uniform thickness may become difficult.) A sheet shape thermal conductive agent is available as material with a uniform thickness. It is also allowed to use such material.

(2) Supply current to thermoelectric cooler

- To protect the thermoelectric cooler and ensure the stable operation, use a supply current to the thermoelectric cooler within a level that is defined on the datasheet.

(3) Securing product with screws

- To screw and secure the product to a heatsink or other parts, set the tightening torque to 0.3 N·m or less and tighten the two screws alternately so that the stress is uniformly applied to the product. If the screw is tightened excessively, the package and heatsink are pushed strongly, causing the package to break.

Thermoelectrically cooled CCD (quartz window type)

Store or use the thermoelectrically cooled CCD (quartz window type) in an environment with low humidity. If the temperature of the window material itself decreases in accordance with the thermoelectric cooling, dew condensation may occur on the external surface of the window in a high-humidity environment. As an example, when the CCD is cooled to $-10\text{ }^{\circ}\text{C}$ at an ambient temperature of $25\text{ }^{\circ}\text{C}$, dew condensation may occur on the external surface of the window at a humidity of 70% or more.

X-ray image sensor

(1) Operation/storage environment

- Since X-ray image sensors are not hermetically sealed products, avoid operation or storage in a high-humidity place.
- Do not apply excessive vibration or impact to the product during carrying.
- Do not use X-ray image sensors in equipment that requires special quality and reliability, and may directly affect human life or cause personal injury if the equipment breaks down or malfunctions.
- When storing the unpacked product, use the packing case delivered by Hamamatsu or a case that is difficult to be charged by static electricity. Be careful not to charge the leads while referring to "4. Electrostatic sensitive devices".
- Before using the product, check the product for fault. If any fault is found, do not use the product. If a fault occurs during operation, immediately stop the operation.

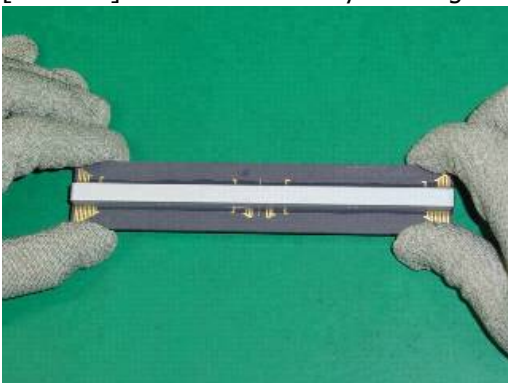
(2) Deterioration by X-ray irradiation

- The product characteristics may deteriorate due to X-ray irradiation exceeding the ratings described on the datasheet of each product. Be sure to use the product within its ratings. In some applications, the product needs to be replaced as a consumable product.

(3) Handling of product with FOS, FOP, or GOS window material

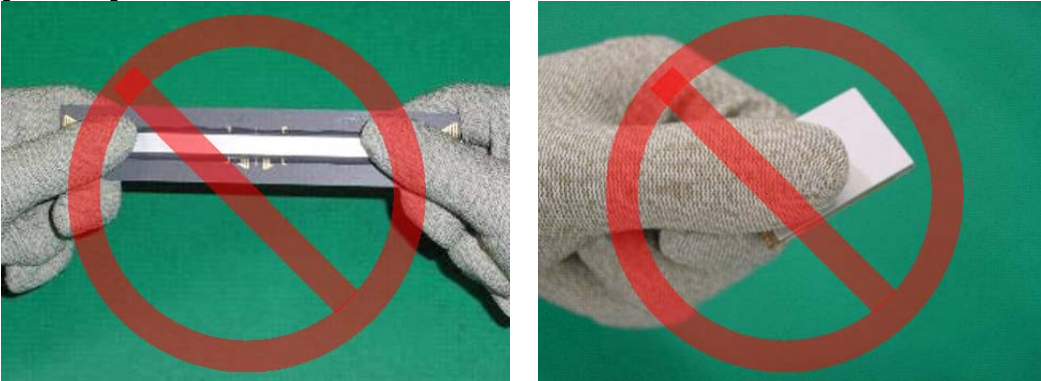
- Since FOS, FOP, and GOS do not have any visible light shading property, carefully check the external light when designing a housing.
- FOP is made from glass, so do not apply strong force or shock.
- The bonding wires are coated with a protective resin, but do not touch the resin part. Doing so may cause wire breakage or faulty wiring.
- When holding the product, hold the board by the edges with fingers.

[Photo 5] Hold the board by the edges with fingers.



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- Do not touch the scintillator section. Contamination or damage of the scintillator may cause changes in sensitivity [Photo 6].

[Photo 6] Never touch the scintillator.



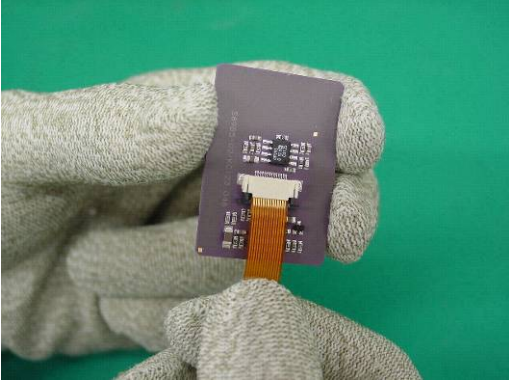
- Never touch the exposed parts of the leads and wirings. Otherwise, the product may malfunction by static electricity.
- Be aware that incorrect insertion may cause malfunctions when mounting the X-ray image sensor on the circuit board.
- When mounting the product with leads on the circuit board, use an applicable socket and push the portion where the X-ray image sensor wiring is not exposed to insert the product [Photo 7].

[Photo 7] Press the board to insert the product.



- For the product with connector, be careful not to apply excessive force to the connector during insertion [Photo 8].

[Photo 8] Do not apply excessive force to the connector.



(4) Handling of product with cable and housing

- Do not apply excessive force to the sensor section. Biting hard orally, applying pressure, or dropping may cause the product to break or malfunction.
- Do not apply excessive bending or tensile force to the cable. Doing so may cause faulty wiring or malfunction.
- When the product is not used, attach the terminal shorting piece (attached at shipment) to the connector and store the product. If the terminal shorting piece is not attached, be careful not to charge the connector pins.

(5) Others

- If using an X-ray image sensor for medical equipment, please contact your local Hamamatsu sales office.

6. Circuit board design precautions

Image sensor driver circuits are unique in that they contain a light input section and both digital and analog circuits, so the following precautions are needed during circuit board design.

(1) Image sensor mounting surface

- The image sensor mounting surface of the circuit board is incorporated into the optical system designed to suppress the input of the external light. So, installing a variable resistor on the backside of the image sensor mounting surface will be convenient for subsequent adjustment work.

(2) Circuit board

- The mounting holes for equipment in the circuit board should be made slightly larger than the screw diameter in order to allow making fine adjustments of the photosensitive area position. Additionally, use a circuit board that will hardly warp due to temperature variations in order to prevent the focus position from shifting.

(3) Circuit components

- Changes in element temperature will also cause changes in characteristics such as the sensitivity and dark current. Using circuit components that emit as little heat as possible is recommended to suppress a temperature rise in the element. Besides keeping the product away from heat-emitting circuit components, please take other measures for heat dissipation.

(4) Grounds

- To prevent digital circuit section noise from intruding into the analog circuit section through the ground, isolate the digital section ground from the analog section ground, and use a thicker ground line to lower its resistance.

(5) Digital signals

- The input clock pulse line causes voltage fluctuations, so separate it as far as possible from the video signal line and voltage supply line. Apply the input clock pulses at the specific timing and voltage to the product connection terminals on the circuit board. Additionally, extra caution is needed during high-speed operation

(6) Analog signals

- Keep the wiring width and wiring distance between the video output terminal and amplifier as short as possible. For the product with the active video and dummy video, set the same wiring width and wiring distance for both the active video and dummy video side signal lines so that they have the same capacitance as much as possible. To prevent noise intrusion into the output signal, keep the video signal line away from digital signal lines such as clock lines that are subject to voltage fluctuations, and also make sure that the video signal lines and digital signal lines do not cross each other on the front or back of the circuit board. This reduces clock feed-through.

(7) Supply voltage

- Fluctuations in video bias voltage, reset voltage, or bias voltage of the on-chip amplifier of the CCD will cause unstable device output characteristics. To avoid this, use a power supply having minimal voltage fluctuations, and ensure that the image sensor supply voltage is not affected by external voltage fluctuations. Do not let voltage fluctuations on the power supply lines caused by circuit board component operation change the product supply voltage. Separate the power supply lines to the product as far away as possible from digital signal lines such as clock lines that are subject to voltage fluctuations.

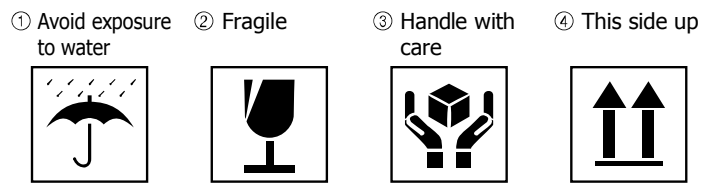
(8) Others

- Noise generated from mechanically driven sections, etc. in equipment, into which the product and circuit board are incorporated, may enter the output signal. Perform the circuit board shielding securely.
- Characteristics may deteriorate during operation at high temperature. Take heat dissipation measures as required.
- If one terminal is shorted to another while a voltage is supplied to the product, excessive current may flow between the terminals, causing deterioration or damage to the product. When monitoring the signal with the probes of an oscilloscope or multimeter, attach the probes to the terminals without supplying voltage to the product, and make sure that the terminals are not shorted by the probes. Then, supply the voltage to the product. When detaching the probes, also make sure that no voltage is supplied to the product.

7. Handling in cardboard boxes

The product comes shipped in cardboard boxes. When handling cardboard boxes, comply with warning labels displayed on the cardboard box.

[Figure 8] Warning displays on cardboard box



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