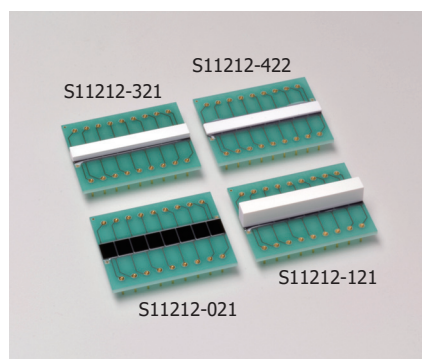


# 16-element Si photodiode arrays



## S11212 series

### Back-illuminated photodiode arrays for X-ray non-destructive inspection

The S11212 series is a back-illuminated type 16-element photodiode array specifically designed for non-destructive X-ray inspection. It has improved sensitivity uniformity and smaller photodiode element variations compared to our previous product (S5668 series). The back-illuminated photodiode array is also simple to handle and easily couples to scintillators without having to worry about wire damage because there are no bonding wires and photosensitive areas on the light incident side. The S11212 series can replace the S5668 series since their package size and pin connections are identical.

#### Features

- Spectral response range: 340 to 1100 nm (S11212-021)
- Element size: 1.175 (W) × 2.0 (H) mm/one element
- Element pitch: 1.575 mm ( × 16 pixels)
- Mounted on board size: 25.4 (W) × 20.0 (H) mm
- Long and narrow format by multiple arrays
- Supports dual energy imaging  
(When used in an upper and lower two-layer combination. See page 7.)

#### Applications

- X-ray non-destructive inspection, etc.

#### Selection guide

Type no.	Number of elements	Element pitch (mm)	Element size W × H (mm)	Board size W × H (mm)	Scintillator			Application example
					Type	Afterglow <sup>*1</sup>	Crosstalk <sup>*1</sup>	
S11212-021 <sup>*2</sup>	16	1.575	1.175 × 2.0	25.4 × 20.0	None	-	-	General photometry
S11212-121					CsI(Tl)	Large	Low	X-ray non-destructive inspection of slow-moving objects (baggage inspection, etc.)
S11212-321					GOS ceramic	Small	Low	X-ray non-destructive inspection of fast-moving objects (baggage inspection, etc.)
S11212-422					Phosphor sheet	Small	May occur.	X-ray non-destructive inspection (at low X-ray energy)

\*1: Relative characteristics when three types of scintillators are compared

\*2: This photodiode array as it is does not function as an X-ray detector. An appropriate scintillator or phosphor sheet should be added at user's side.

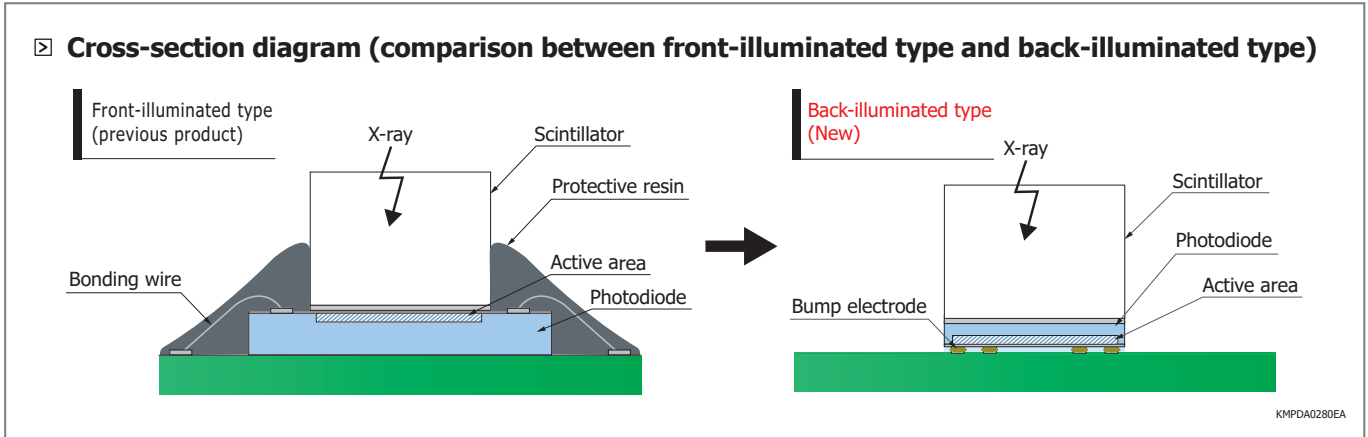
Note: The S11212 series are also compatible with other scintillators than those listed in the above table (custom made devices). Please consult our sales office.

#### Precautions

CsI(Tl) scintillator of the S11212-121 has deliquescence. Avoid storing or using the S11212-121 at high humidity.

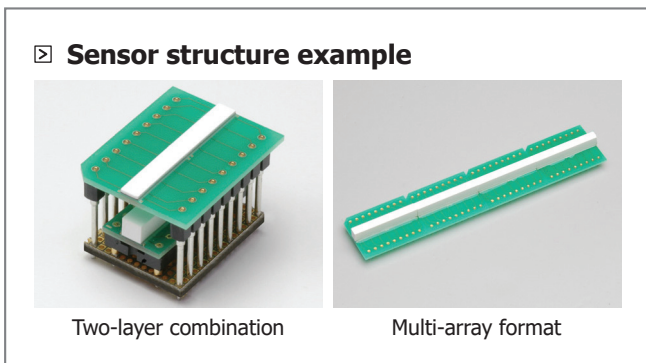
**Feature 01 Back-illuminated type**

The S11212 series photodiode arrays have a back-illuminated type structure. This structure uses no fragile easily-broken bonding wires since the photodiode array output terminals are directly connected by bump bonding to the electrodes on the board. This structure is robust since the board wiring is laid out within the board. The photodiode surface for coupling the scintillator has no bonding wires or photosensitive areas, so there is less risk of damaging the photodiode array. The S11212 series is also resistant to effects from temperature cycle and so ensures high reliability.



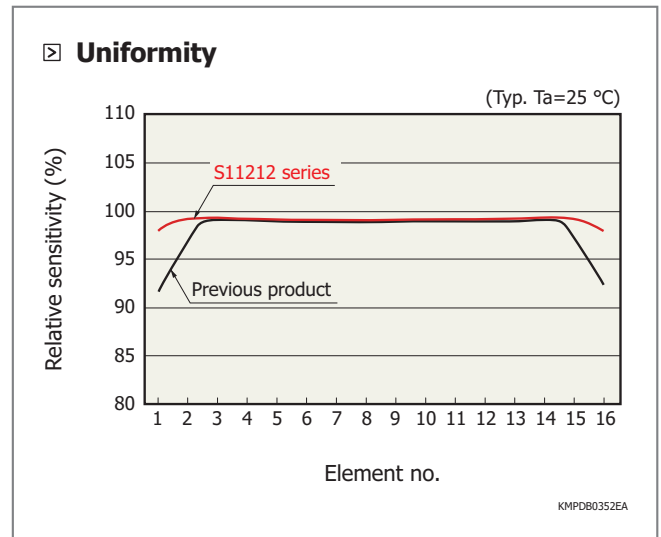
**Feature 02 Multiple applications**

The S11212 series supports dual energy imaging. To simultaneously detect high energy X-rays and low energy X-rays, the S11212 series is designed so that two photodiode arrays, each with a different scintillator, are combined in an upper and lower two-layer format. Arranging two or more S11212 series photodiode arrays in a row in close proximity also forms a line sensor that allows measurement of long objects.



**Feature 03 Superb uniformity**

Our unique sensor design minimizes variations in sensitivity between photodiode elements as well as at the sensor ends. The S11212 series offers significantly improved sensitivity uniformity compared to our previous product (S5668 series) and so provides optimal X-ray images.



**Absolute maximum ratings**

Parameter	Symbol	S11212-021	S11212-121/-321/-422	Unit
Reverse voltage	$V_R$ max	10	10	V
Operating temperature*3	$T_{opr}$	-20 to +60	-10 to +60	°C
Storage temperature*3	$T_{stg}$	-20 to +80	-20 to +70	°C

\*3: No dew condensation

When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

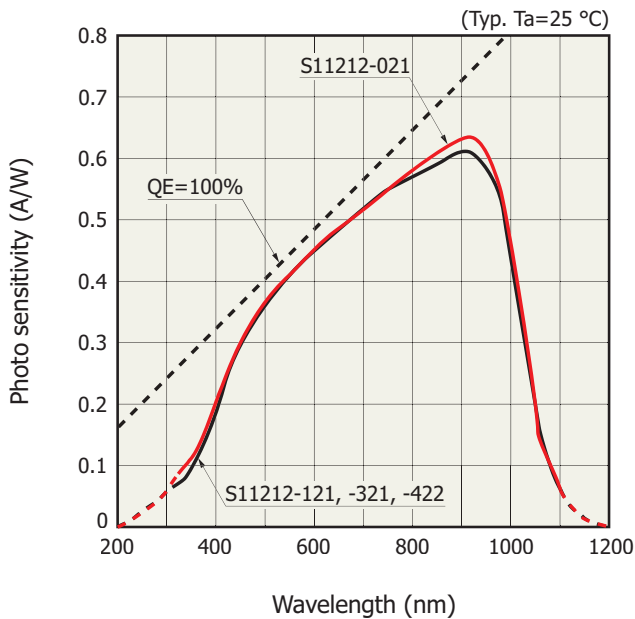
**Electrical and optical characteristics (Ta=25 °C, per element, S11212-021 characteristics except X-ray sensitivity)**

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	
Spectral response range	$\lambda$		-	340 to 1100	-	nm	
Peak sensitivity wavelength	$\lambda_p$		-	920	-	nm	
Photosensitivity	S	$\lambda=540$ nm	380	420	460	mA/W	
		$\lambda=\lambda_p$	550	610	670		
Short circuit current	$I_{sc}$	*4	S11212-021 2.7	3.4	-	$\mu$ A	
X-ray sensitivity	$I_{scX}$	*5	S11212-121	-	6.0	-	nA
			S11212-321	-	3.5	-	
			S11212-422	-	3.0	-	
				-	-	-	
Dark current	$I_D$	$V_R=10$ mV	-	5	30	pA	
Rise time	$t_r$	$V_R=0$ V, $R_L=1$ k $\Omega$ 10 to 90%, $\lambda=658$ nm	-	6.5	-	$\mu$ s	
Terminal capacitance	$C_t$	$V_R=0$ V, $f=10$ kHz	30	40	50	pF	

\*4: 100 lx, 2856 K

\*5: These are reference (X-ray tube voltage 120 kV, tube current 1.0 mA, aluminum filter t=6 mm, 830 mm). X-ray sensitivity depends on the X-ray equipment operating and setup conditions.

**Spectral response (characteristics without scintillator)**

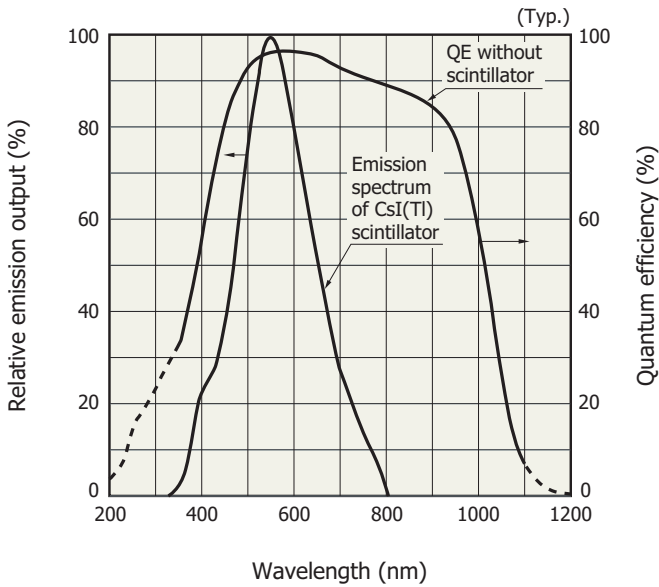


Spectral response characteristics of the S11212-121, -321, -422 include the transmittance and reflectance of the adhesive resin used to bond a scintillator.

KMPDB0350EC

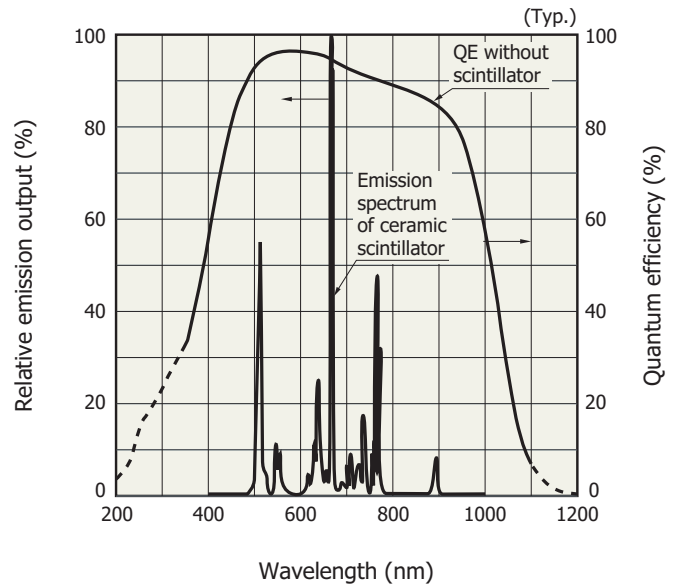
❏ Emission spectrum of scintillator and spectral response

S11212-121



KSPD80282EE

S11212-321



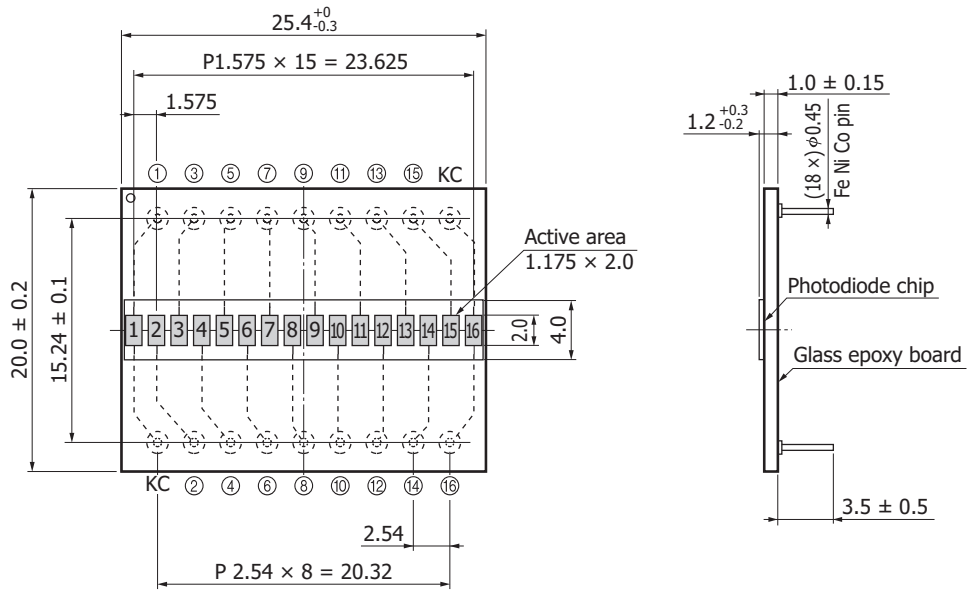
KSPD80281EE

❏ Scintillator specifications

Parameter	Condition	CsI(Tl)	Ceramic	Unit
Peak emission wavelength		560	512	nm
X-ray absorption coefficient	100 keV	10	7	cm <sup>-1</sup>
Refractive index	at peak emission wavelength	1.7	2.2	-
Decay constant		1	3	μs
Afterglow	100 ms after X-ray turn off	0.3	0.01	%
Density		4.51	7.34	g/cm <sup>3</sup>
Color		Transparent	Light yellow-green	-
Sensitivity non-uniformity		±10	±5	%

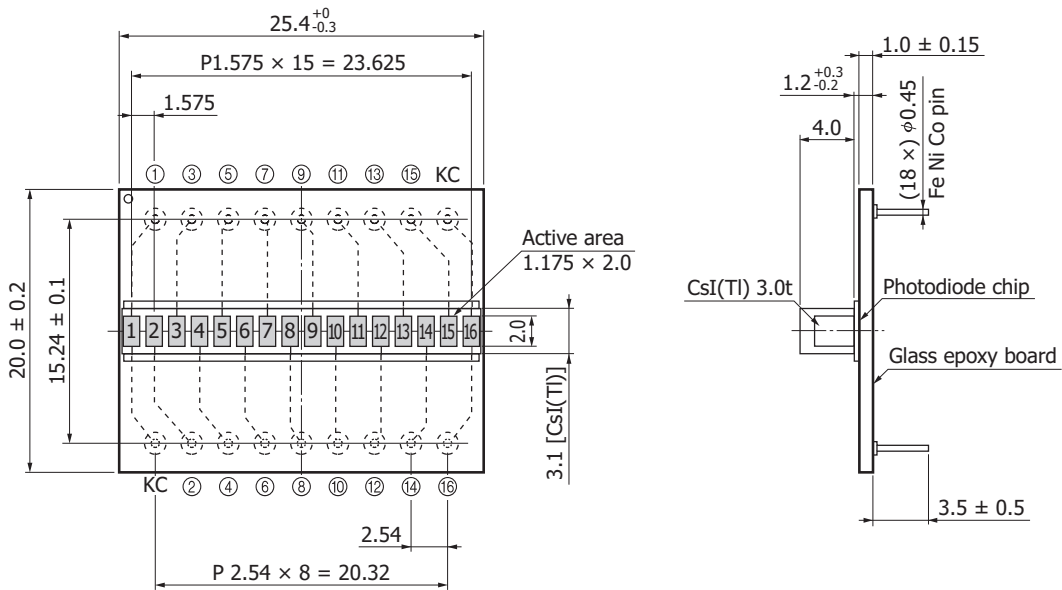
Dimensional outlines (unit: mm, tolerance:  $\pm 0.1$  mm unless otherwise noted)

S11212-021



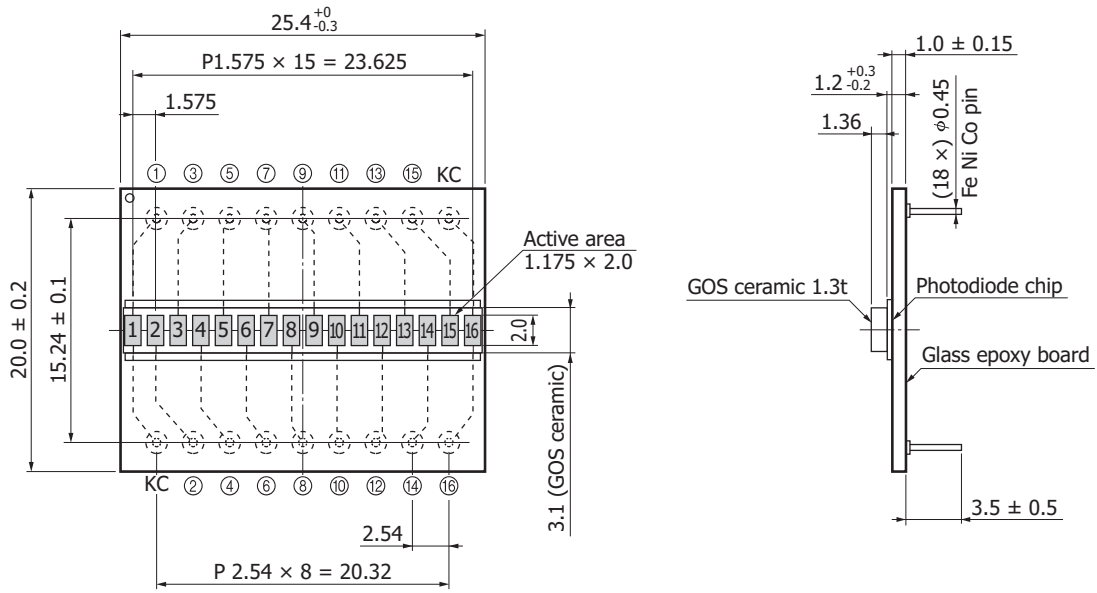
KMPDA0269EC

S11212-121



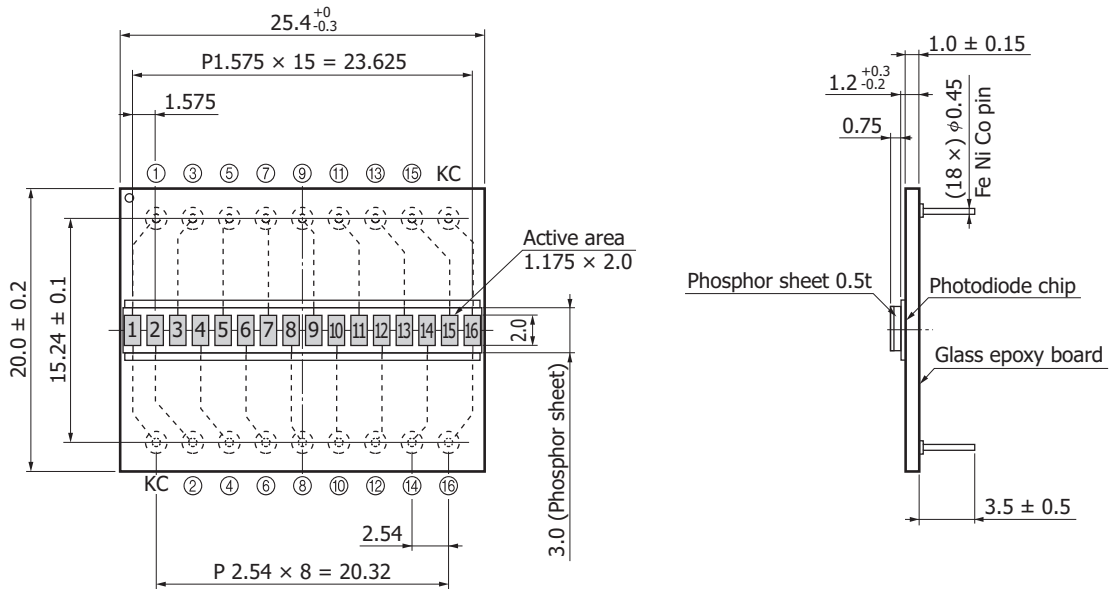
KMPDA0273EB

S11212-321



KMPDA0274EB

S11212-422



KMPDA0275EC

### ☒ Combination examples (for dual energy imaging)

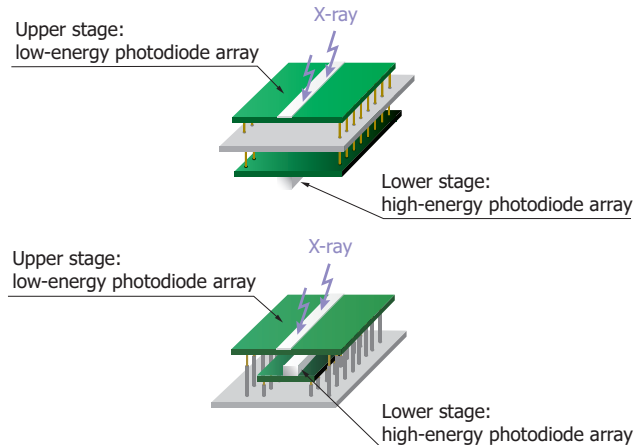
Dual energy imaging is a technique that acquires and superimposes two types of data in a single scan by using X-rays at two different energy levels (high energy and low energy). Two photodiode arrays with scintillators are used: one at the upper stage and the other at the lower stage. The upper stage is used for low energy detection, and the lower stage for high energy detection. Arranging two or more of these devices in a row also forms a line sensor for dual energy imaging.

① This combination uses the S11212 series in both upper and lower stages.

- [Upper stage] S11212-422 + [Lower stage] S11212-121
- [Upper stage] S11212-422 + [Lower stage] S11212-321

② This combination uses the S11212 series in the upper stage and the S11299 series in the lower stage

- [Upper stage] S11212-422 + [Lower stage] S11299-121
- [Upper stage] S11212-422 + [Lower stage] S11299-321



Note: For details on the S11299 series, refer to the S11299 series datasheet.

### ■ Related information

[www.hamamatsu.com/sp/ssd/doc\\_en.html](http://www.hamamatsu.com/sp/ssd/doc_en.html)

- Precautions
- Disclaimer

Information described in this material is current as of September 2021.

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